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INCANDESCENT LAMP PATENTS.

MR. JUSTICE BUTT has done what Mr. Justice North declined to do: a question of degree having arisen in an action relating to a patented invention, he has boldly placed the limitation which he conceived the patentee intended upon certain words in the specification,—not a precise limitation, but one sufficient for the purposes of the action. In the memorable telephone patent case, "United Telephone Company *v.* Bassano," Mr. Justice North, notwithstanding that no reasonable man could for a moment suppose that Edison intended to claim as part of his invention any substance, of whatever form or magnitude, which would respond to the vibrations of the air and thus transmit sound—and, according to scientific evidence, there is scarcely any substance which will not so act—held that "diaphragm," as used in Edison's specification, covered the use of the wooden framework of the Bassano telephone. It was a question of degree only, and, although Edison's diaphragm had a definite form and a definite locality, nothing which could be said, as a matter of scientific knowledge, to possess vibratory power could be used in any way in connection with a telephone without infringing Edison's patent rights. Regarding the filament in an Edison incandescent lamp and the carbon pencil in the lamp of Swan, Mr. Justice Butt says, it may be a question of degree, but degree is all-important. Although a carbon pencil $\frac{1}{25}$th of an inch in diameter has been called a filament, it is not the carbon filament which Edison contemplated when he used the expression in his specification. And thus the two judges differ in their method of dealing with the language of a specification. One says, it would be unfair to Edison to limit his meaning; the other, it would be unfair to him not to do so.

As no doubt the greater part of our readers are now aware, it was upon this question, whether the carbon rod or pencil in the lamp which Mr. Swan exhibited and described at Newcastle-on-Tyne in the year 1878 could fairly be called a filament, that the whole case eventually turned in the action decided last week, "Edison and Swan United Electric Light Company *v.* Woodhouse and Rawson." Many other reasons were brought forward in the first instance to show, first, that the Edison patent of December, 1879, which was the subject of the action, was not valid, inasmuch as it had been antedated by numerous inventors and scientists, and, secondly, that, even though valid, the defendants had not infringed it. No less than 75 anticipations were alleged; but as the case proceeded it was evident that these would have but little weight with the judge, who, at a comparatively early stage, intimated his doubts whether a lamp of mosaic construction, consisting of the glass receiver of one man, the carbon filament of another and the vacuum of a third, was an anticipation of Edison, who claimed the combination of these things, and not each one separately.

Upon the evidence with regard to anticipation, it seems to us that but little fault can be found with Mr. Justice Butt's decision. But when we take a wider view, we are not quite sure that there is abundant reason for satisfaction with the result. In the first place, it seems a pity that Mr. Swan himself was not put into the witness box. Had he been examined, he might have been induced to tell something of the experiments he made with carbonised paper as far back as 1860 or 1861, and of the carbon wire, "steel-like in its elasticity," and $\frac{1}{100}$th of an inch thick, which he also used with some degree of success. (See ELECTRICAL REVIEW for December 1st, 1880, page 409.) Indeed, it is curious that these points were overlooked, or were not adverted to, at the recent trial. Then, the construction which the Court put upon the second claim in Edison's specification was not quite that which we have been accustomed to regard as the right construction. We have always considered that the strength of the patent lay in the filament—a special conductor, made as described; that is to say, a filament formed by carbonising a vegetable base. To this we think Edison is entitled; but such a lamp as that of Cruto, in which pure carbon is deposited upon a platinum wire, and in which, therefore, no vegetable base is employed, would surely be outside the Edison claims. With regard to the Woodhouse and Rawson filament, there was no evidence which more than suggested the possibility of its having been "made as described" by Edison.

Mr. Justice Butt, however, took the view, in which we cannot follow him; that the terms of the specification are to be taken as meaning *any* carbon filament, *however made*. True, it is the first claim which alone specifically mentions "a filament of carbon . . . . made as described," and of this claim the learned judge held there was no infringement. But surely it is not unreasonable to say that Edison implied the same thing when he wrote, in his second claim, "a carbon filament," without adding the further descriptive phrase contained in the first. It is in this respect, and in this alone, that we differ from the finding of the Court. It is a pleasure to say that the learned judge consistently sought throughout the trial to reduce matters to the simplest and plainest issues, and to avoid those legal quibbles and niceties for which a case of this character offers considerable opportunity; and if we cannot unhesitatingly concur in his decision, we can bear testimony to his conscientious endeavour to take the proper view of the evidence, difficult, and in some cases conflicting, which was put before him.

We presume the case will proceed to appeal, and, in that event, trust that the party which has right and justice on its side will ultimately secure the verdict; but we do hope that, should Mr. Justice Butt's decision be confirmed, electric lighting will not be retarded as a consequence.

HOW TO WIND THE MAGNETS FOR SHUNT, SERIES, AND COMPOUND MACHINES.

By CARL HERING.

VI.—COMPOUND MACHINES.

LET it be required to wind the machine compound, that is, with both series and shunt coils, so that the difference of potential at its poles shall remain constant, or nearly so, for any number of lamps.

The general principle of the compound winding is as follows: In a simple shunt machine, the greater the current in the external circuit or in the armature, the greater will be the fall of potential in the armature itself, due to its resistance, and therefore the less will be the potential at the terminals of the shunt coils. This decreases the current in them, thus diminishing the magnetism, which again decreases the potential. The potential at the poles of the shunt machine must, therefore, fall a certain definite amount with an increase of the number of lamps in circuit. The increased "counter magnetism" of the armature, due to its own current, also tends to decrease the potential for an increased current.

If by some means these losses of potential due to an increased current could be replaced automatically by an exactly equal amount by increasing the magnetism proportionally, it is evident that the potential at the poles could be made to remain constant, or nearly so. This may be done by adding series coils to such an amount that the total magnetism of the field increases with an increasing current in the external circuit, so that the potential at the poles of the machine is maintained constant. To show how to properly proportion the series and shunt coils so that the machine will give this constant potential at its poles, is the object of this article.

The connections of the shunt coils may be made in one of two ways. In the first of these, called the ordinary compound machine connection, and shown in fig. 3, the terminals of the shunt coils are connected to the poles of the armature, or what is the same thing, to the brushes. The current in the series coils is, therefore, not the total current of the armature, but the current in the external circuit, or what is the same thing, the armature current less the shunt current. When no lamps are burning, the series coils are idle, the shunt coils alone being used to keep the machine at its proper potential. If the potential at the poles of the machine is constant, it will not be so at the poles of the armature or at the brushes, and, therefore, not at the terminals of the shunt coils. The potential at the latter will be equal to that at the poles of the machine, increased by that which is absorbed in the series coils, which latter quantity is evidently the current in the external circuit multiplied by the resistance of the series coils, and is, therefore, a variable quantity depending on the number of lamps in circuit. The current in the shunt coils is, therefore, not a constant one, but depends to a small extent on the number of lamps burning.

The second system of connecting the coils is called by Prof. S. P. Thompson the "long shunt" method, and is shown in fig. 4. The terminals of the shunt coils are not connected to the brushes as before, but to the poles of the machine. The potential at these points being constant, the current in the shunt coils is constant for all loads, and represents, therefore, a constant magnetisation such as from steel magnets or from a separate exciting machine. The current in the series coils is in this system the whole current of the armature, because the current passes from the brushes directly into the series coils and afterwards divides between that in the external circuit and that in the shunt. The series coils act to a certain extent both as series and shunt coils, for the current in the shunt coils flows through the series coils as well, and when the machine is on open circuit, the shunt current has to flow through the series coils first, thus making them act as shunt coils also.

It is a question which of these two systems is more economical as regards material, operation and construction, though it is probable that the second or "long shunt" method is the better. In regard to material, the second is probably cheaper, for although there is a trifle more lost space between the wires, owing to the thicker wire of the series coils, yet there is less space and material wasted in the insulation. For suppose we were to wind a thin shunt wire and a thick series wire together to take the place of the single series wire of the second method which carries both these currents, the two wires would evidently take up more room and would cost more in material than the one thick wire, although answering the same purpose. In regard to the economy of operation of the two systems there is probably very little difference. There may be a slight difference in favour of the "long shunt" method, because the magnets will be slightly less bulky. In regard to economy of construction, there is less work required to wind the magnets in the second case, as there are always less windings in all. If certain errors in the calculations, which may often be neglected, are corrected, the long shunt method becomes somewhat easier to calculate than the ordinary. In many cases, especially for large, well-proportioned machines, there will be very little practical difference between the two methods.

The test of the machine, preceding the calculations for the proper proportions of the series and shunt coils for either the ordinary or the long shunt method, is the same for both, and is made as follows, independently of the method of winding which will be used.

Make the test for determining the magnetism, with temporary coils and a separate exciting machine, in the same way as was described for shunt machines, only that instead of making but one test for full load, make a series of tests (as many as practicable—say 15 to 20) beginning with a little more than full load, and continuing by diminishing the number of lamps, down to an open circuit or no lamps. For each different number of lamps, adjust the exciting current until the potential is the required amount and then measure both the exciting current and that in the lamp circuit, being careful that the speed remains the same, for with a poorly governed engine the speed is likely to increase as the number of lights diminishes. The speed should be noted and *must not be changed*, as the proportioning of the coils is different for different speeds. The machine should be run for a time on full load or even more, so as to become warm throughout. In the absence of a reliable ampèremeter for such a large range as is required for the current in the external circuit, it is sufficiently accurate, if the lamps are uniform, to calculate the current in the external circuit from the number of lamps, by measuring accurately, once for all (and with the same instrument to be used for the exciting current) the current required by a large number

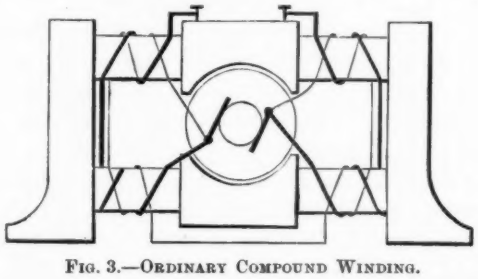


FIG. 3.—ORDINARY COMPOUND WINDING.

of lamps *at their proper potential*, and dividing this by their number. This constant gives the current per lamp and can be used to calculate the currents for the decreasing number of lamps. In this case, even if the constant of the instrument is not quite correct, the relative values of the lamp current and the exciting current are correct, and the test will give values which will answer the purpose. It is important to adjust accurately for the proper potential in each case, otherwise the results will be very unsatisfactory.

Before making this series of measurements it is advisable to examine the shifting of the diameter of commutation. To do this, run the machine at full load at the proper potential and adjust the brushes to the non-sparking position, then disconnect all but a few of the lamps, and run it again at the proper potential by changing the exciting current, and find the non-sparking position of the brushes again. If the change of position is very great, it is not advisable to attempt to make the machine a self-regulating compound machine, as it will be very unsatisfactory; in fact it will evidently not be automatic if the brushes require to be adjusted. If the change of position is great, there are some wrong proportions in the machine, at least, for a compound machine. Probably it is the fault of the armature, as it may have too many windings, or its iron may be too hard, or there may be too few commutator strips, the self-induction being too great. It may also be the fault of the pole pieces, as they may be too wide in the direction of rotation. Perhaps the field is unbalanced, having the iron unsymmetrically placed in the form of arms, bearings, base, &c. The brushes should not touch more than two, or at the most three commutator strips at one time, and they should be precisely diametrically opposite each other. General hints, in regard to the best proportions, to prevent the shifting of brushes, will be given in the latter part of this article.

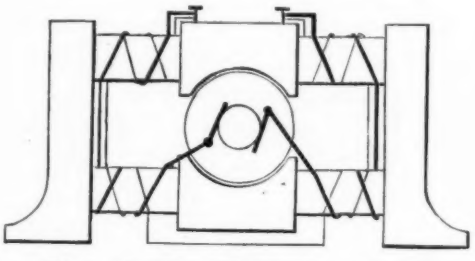


FIG. 4.—COMPOUND WINDING—LONG SHUNT.

If the change of position of the brushes is more than about one-half inch, on a commutator of about 4 inches diameter, the machine is not well proportioned. A good compound machine ought not to spark or require the brushes to be moved, even for a sudden change from a full load to an open circuit or the reverse. They should only be moved when worn off. It is, of course, taken for granted that the contact surface of the brushes is more than the thickness of one insulation between the commutator strip, and that they are exactly diametrically opposite each other.

If the brushes need slight adjusting, it is best to find a mean position and keep them there for all loads, provided they do not spark too much to injure the machine for the extreme loads.

INCANDESCENCE LIGHTING.

IN the present article we return to the subject treated of in our leading columns a few weeks ago, and to the solutions which we mentioned as being of special importance in connection with the life of glow lamps. The problem to be solved is at what strain * should lamps be worked to obtain minimum annual expenditure when the power is supplied by a gas engine burning London gas at 3s. per 1,000 cubic feet, assuming the relation given in our former article between the strain and the duration to be true? We shall deal with an installation of 50 lamps of 20 candle-power, the total light produced being, therefore, 1,000 candles, and we shall further assume that the lamps are lighted for 1,000 hours annually. The actual strain on lamps as now installed varies from ·2 to ·4, and we will confine our remarks to lamps within those limits, taking their cost at 5s. each.

The consumption of gas in gas engines has been determined at 30 cubic feet per brake horse-power per hour, and by calculation, knowing the commercial efficiency of the dynamo, the number of watts appearing in the lamp circuit for each cubic foot of gas consumed per hour could be easily determined. But it is probable that a calculation of this sort would give a result too high, since in driving from gas engines with a fly-wheel on the dynamo a certain amount of slip must be allowed, which means a small loss of power. Our best plan is therefore to trust to no calculation, but to measure directly the gas consumed and the electrical energy appearing in the circuit, all losses in transmission being thus included in the results. From several determinations of the relation between the gas consumed and the watts appearing in the lamp circuit it seems that for each cubic foot of gas consumed per hour an average of about 17 watts can be obtained from a gas engine combined with a good dynamo. About 25 cubic feet of gas is consumed for each indicated horse-power developed by the engine, and having a list of engines with their horse-powers given we can find what amount of gas each is capable of burning by multiplying the I.H.P. by 25. To obtain the number of watts which the engine and dynamo combined are capable of producing in the lamp circuit, this product must be further multiplied by 17.

What we have to determine first is the initial cost of the installation, and this must be somehow expressed in terms of the strain on the lamps. We know that if the strain is high a less amount of power will be required, and consequently a smaller size of gas engine than if the lamps are worked at a low strain. In Table I. are given the costs of various sizes of Otto gas engines including fixing and foundations. Since in our calculations we are limited by strains of ·2 and ·4 respectively, we have only taken engines which supply power between 5,000 and 2,500 watts, which output for 50 lamps corresponds to these limits.

TABLE I.

COST OF OTTO GAS ENGINES.

I.H.P.	Gas consumed per hour.	Watts in lamp circuit.	Strain.	Cost in £.
5·9	147·5	2507·5	·398	190
11·5	287·5	4887·5	·204	230
14·7	367·5	6247·5	·160	270

Column 2 of the table is obtained by multiplying the I.H.P. by 25, and represents the maximum amount of gas which the different sizes of engines are capable of burning with economy. Column 3 is found by multiplying column 2 by 17, and may be considered the maximum number of watts which can be obtained from the engine and dynamo combined.

The costs of dynamo machines giving an output varying from 2,500 to 5,700 watts as published in the price lists of well-known firms are given in Table II., and include fixing, foundations and belting. The relation between the cost of the machine and the strain on the lamps is also given in the table.

TABLE II.

COST OF DYNAMO MACHINES.

Watts in lamp circuit.	Strain.	Cost in £.
2,500	·400	60
3,200	·312	70
4,400	·227	80
5,700	·175	90

* Our readers will remember that "strain" is defined as the fraction of candle-power given by the lamp per watt of energy consumed.

From these tables it will be seen that the cost of the gas engine cannot be regarded as a simple function of the strain, nor can the cost of the dynamo. Looking at Table I. we find that if it is wanted to diminish the strain by ever so little less than ·398 we must put in an engine costing £40 more, which is, however, capable of working the lamps at a strain of ·204. Any line then which may be drawn to express graphically the relation between the strain and the cost will not be a curve, but will be a line ascending in a series of steps and made up of horizontal pieces joined by vertical

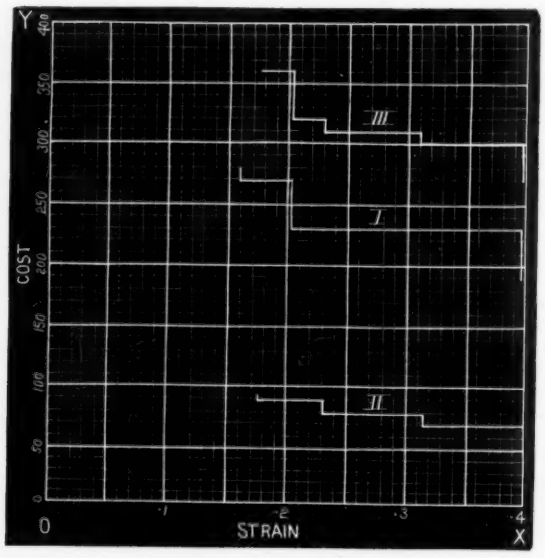


FIG. 1.

pieces, as shown in fig. 1. Here distances along O X represent strain and vertical heights the cost. Line I. represents the cost of the gas engine and II. that of the dynamo, III. being the sum of the two.

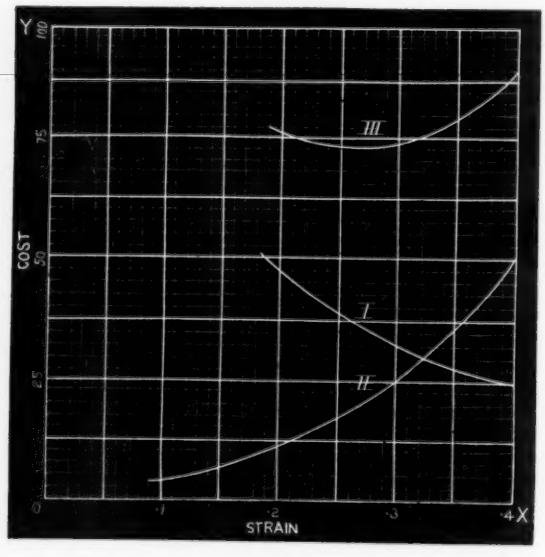


FIG. 2.

The lamps we have taken at 5s. each, and allowing 25s. per lamp as the cost of supplying and fixing conductors, switches and fittings, we have £75 as the sum to be added to the cost of the engine and dynamo in order that the total initial cost of the installation may be represented. It might be said that the items enumerated above are not independent of the strain, inasmuch as when the lamps are less strained the size, and consequently the cost, of the conductor becomes increased. Although this is true, we do not consider it worth our while to find how the cost of the conductor will vary with the strain, since the modification introduced by this consideration would be very trifling. We shall therefore imagine that the cost of the conductors is not influenced by the strain, and that the only costs depending on the latter are those of the engine and dynamo. We shall add the above £75 to the cost of engine and dynamo and take the interest, depreciation and repairs at 10 per cent. per annum all round. Line I. fig. 3 represents for different values of the strain this annual cost due to interest, &c., on capital sunk.

So much for the annual interest cost. We have now to consider the cost of maintenance. The maintenance cost embraces the charges for attendance, for lamp renewals, and for fuel and oil. The former of these is, of course, independent of the strain and may be taken at £15 per annum, the proportion of a lad's time occupied in cleaning the engine, &c., being charged under this head. The lamp renewals depend on the strain at which the lamps are worked, so does the gas consumption, and finally, the cost of the oil used may be considered as related to the cost of the gas in the way shown in Table III. This table gives the annual maintenance cost on the assumption that lamps strained to ·2, ·3, or ·4 last respectively 1,000, 500, or 250 hours.

TABLE III.

ANNUAL MAINTENANCE COST FOR 50 LAMPS.

Strain.	Watts.	Gas consumed in thousands.	Annual cost of gas.	Annual cost of oil, &c.	Annual cost of lamp renewals.	Attendance charges.	Total maintenance cost.
·2	5000	294	£44·10	£4·4	£12·5	£15	£76·00
·3	3334	196	£29·40	£3·0	£25·0	£15	£72·40
·4	2500	147	£22·05	£2·5	£50·0	£15	£89·55

We have now the annual interest cost and the annual maintenance cost expressed in terms of the strain, and by plotting these as curves, their values being represented by ordinates and the strain by abscissæ, we can illustrate graphically the relation existing between them. Such curves are given in fig. 2, where I. is the annual cost of gas and oil, &c., and II. the annual cost of lamp renewals. Curve III. gives the total maintenance cost, and in fig. 3 this is combined with the annual interest cost to obtain the value for the strain which makes the total cost a minimum. Line I., fig. 3, is the interest cost, and line II. the maintenance cost, and it will be seen that the sum of these two costs, III., has a minimum value when the strain is ·275 or when we expend energy at the rate of about 3·6 watts per candle-power.

It will be understood that this is true only on the assumptions which we have made regarding the cost of lamps and their durability. The factors affecting the result are numerous, and there must of necessity arise slight modifications for each installation treated, but we can say that, in the present stage of lamp manufacture, a lamp strained to ·275 is an economical one, and that in any case the most economical strain will not vary much to either side of that given. It will be observed that for a considerable variation in strain the total cost is not materially increased or diminished, the line for some distance remaining approximately horizontal at the lowest part of the curve (III., fig. 3), so that a certain latitude remains to us in the choosing of the lamps. It ought also to be remembered that the interest and maintenance charges which are independent of the strain—such as interest on first cost of lamps, fittings and wiring, and cost for attendance—while influencing the total annual cost, do not, by increasing or diminishing, affect the strain at which the lamps should be worked, which is influenced only by the variable factors. We need scarcely say that quite a different solution would be obtained with Dowson gas as fuel, for with diminished outlay for

fuel, the strain would be reduced and a diminished annual expenditure would be the final result.

The second problem to be solved is, what must be strain to obtain maximum economy when the power is supplied by a factory engine, the power for the lights being so small relatively to the total power given out that the interest on the motor supplying it may be in our calculations neglected? We shall suppose that the installations consists of 300 lamps of 20 candle-power each, the total light given being that of 6,000 candles, and we shall further suppose that they are lit for 1,000 hours per annum. The price of fuel varies so much in different districts that we encounter at the outset some difficulty in fixing the cost of the power, but we believe we shall be sufficiently near the mark if we assume that for every 1,000 watts appearing in the lamp circuit we have to pay annually in fuel, oil, &c., £3. This figure includes, as in the case of gas engines, all losses in transmission; we are concerned only with the fuel put into the furnace at one end and the watts appearing in the circuit at the other.

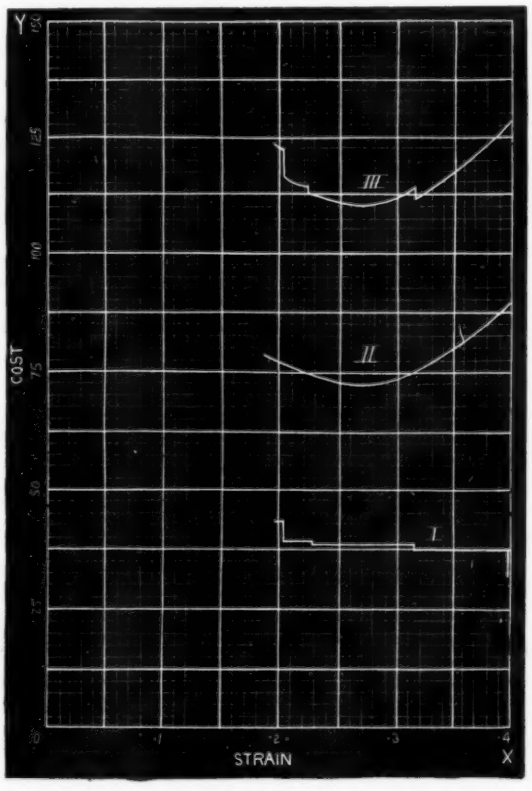


FIG. 3.

The following Table IV. gives the cost of the dynamo, and, as before, includes price of belting, of foundations, and of fixing in place.

TABLE IV.

COST OF DYNAMO MACHINES.

Watts in lamp circuit.	Strain.	Cost in £.
15,800	·380	200
18,900	·317	210
22,200	·270	225
25,200	·238	280
28,400	·211	300
31,600	·190	320
47,400	·127	440

The supplying of lamps, conductors, fittings, &c., may, for an installation of this kind, be taken at 22s. 6d. per lamp, which makes a sum of £337 10s. to be added to the cost of the dynamo in order that the total first cost may be obtained.

The cost of maintenance is given in Table V., £60 per annum being charged for attendance.

TABLE V.

ANNUAL MAINTENANCE COST OF 300 LAMPS.

Strain.	Watts.	Annual cost of coal and oil.	Annual cost of lamp renewal.	Attendance charges.	Total maintenance cost.
·1	60,000	£180	£18·75	£60	£258·75
·2	30,000	£90	£75·00	£60	£225·00
·3	20,000	£60	£150·00	£60	£270·00
·4	15,000	£45	£300·00	£60	£405·00

It is not worth while repeating all the graphic representation for the solution of the problem, so we merely give the result. Taking the interest, depreciation, and repairs at 10 per cent., as before, the annual cost is shown to be a minimum when the lamps are strained to ·2, or where the energy absorbed is 5 watts per candle. The latter result will probably astonish electricians who have been eager in the pursuit after lamps taking 2½ watts per candle, or less. Of course it could be seen without any calculation that in working with a steam engine the strain should be less than when a gas engine is used, owing to the diminished cost of the fuel employed. As a matter of fact the whole question hangs upon the relation between the strain on the lamp and its duration, and we have only had data of a not very satisfactory kind to rely upon for this. With the data at our disposal we have, however, done our best, and we believe the relation we have given is a fair one. Upon the life of the lamp depends the cost of renewals, and if lamps were cheaper we could afford to put a greater strain on them and thus lessen the annual cost. Having regard to recent law proceedings it is not likely that lamps will be cheaper for some time, and improvements serving to increase their duration seem to take place but slowly. With lamps at their present prices, and with their present lasting powers, a lamp taking 4 watts per candle, or strained to ·25, is a good average lamp to be used on any installation whether the power is supplied by gas or steam.

WIMSHURST'S INFLUENCE MACHINE.

THE Wimshurst influence machine is now extensively known, and is fast replacing other electro-static generators in use in physical laboratories. Its rapid introduction is due mainly to three characteristic features, viz: (1), its remarkable independence of atmospheric condition; (2), its power of self-excitement; and (3), its constancy of polarity.

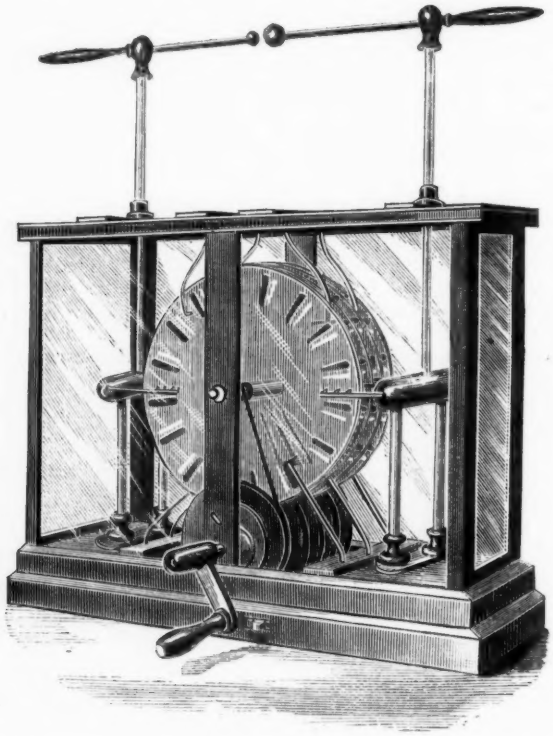
It has given every satisfaction without any preliminary treatment in crowded lecture theatres in which other influence machines behaved most disappointingly. It has also been frequently placed in trying and even in extreme hygrometric conditions, and found to work admirably. As to initial electrification, it never wants any. As soon as the varnished plates with their metallic sectors are fitted with their brushes and spun round in proximity to each other, a charge is invariably and rapidly built up. One side of the machine becomes positive with respect to the other, and this electrical state is maintained as long as the machine is kept working.

Much useful information as to the manner of making and using these machines may be obtained from a little pamphlet published lately by Mr. Thomas Gray, C.B. This work is a reprint of matter which appeared in the *English Mechanic* between November, 1884, and October, 1885, to which Mr. Gray adds some experi-

ments made with his multiple-plate machine bearing chiefly on the flow of the electrical current.

The machine, the illustration and description of which we reproduce from *Engineering*, is the latest one constructed by Mr. Wimshurst in his amateur workshop at Clapham. It consists of eight of the well-known plates—which may henceforth be aptly called by the distinctive appellation of Wimshurst plates—each being $2\frac{1}{3}$ feet in diameter and carrying sixteen sectors. When the plates are rapidly rotated in opposite directions, a high degree of electrification is produced. In order to diminish as much as possible the loss of charge arising from the usual causes, all the conductors, and even the rods carrying the metallic brushes, are covered with a thick coating of gutta percha, and the whole apparatus is enclosed within a tightly-fitting and dust-excluding glass case. In like manner, the brass rods which lead from the prime conductors to the outside terminals, are carried up through glass tubes. By these means, the losses due to leakage and discharge to neighbouring bodies are greatly reduced, and the efficiency of the machine correspondingly increased.

Some idea of the electrical power developed by this machine may be formed from the easily reproducible fact that every turn of the handle gives six sparks each of 8 inches in length. One complete revolution, therefore, generates a quantity of electricity corresponding



to a disruptive discharge of 4 feet length. Sparks of 10 inches and 12 inches are readily obtained. Some of the former have been photographed and are remarkably beautiful, showing in a marked manner the multiple and branching character, as well as the zigzag path of the discharge between terminal and terminal.

The condensers used were made of ordinary hock bottles, and the discharge was accompanied by an almost unbearable snapping noise, comparable in loudness to a pistol shot.

This machine was specially constructed for the course of afternoon leetures now being given by Prof. George Forbes at the Society of Arts. In one of these, in order to show the strain produced in a dielectric medium when acted upon by an electromotive force, the professor endeavoured to repeat a famous experiment of Dr. Kerr's. Two wires leading from the terminals of the machine, dipped into mercury contained in two small glass bulbs. These were immersed at a little distance from each other in a cell containing carbon disulphide. A beam of polarised light was then passed through the liquid, and the analyser turned until the light was cut off. It was duly explained that the stress to which the liquid dielectric (CS_2) would be subjected on turning the machine would be made manifest by the reappearance of the light on the screen. The stress, however, proved to be so great as to noisily shatter the glass bulbs before any optical effect could be perceived. The point was thus demonstrated in an unmistakable and probably unwished-for manner. The same principle of strain was again illustrated in the case of Leyden jars by separating the terminals of the machine as far as possible, and rapidly rotating the plates. Though the walls of the jars were unusually thick they were unable to resist the intense electrostatic strain produced by the high electromotive force of the machine. This electromotive force has been measured in terms of that of a Daniell's cell, and found to be 50,000 volts, while the current has been estimated at the $\frac{1}{3000}$th of an ampère.

In an elementary class-book on electricity just published,* we notice that one of the sections is headed "The Voss or Wimshurst Machine." This evidently implies the identity of the two electrostatic generators, which is an error. Moreover, when the author, proceeding with his description of the Voss, says that "one plate is fixed," he has said quite enough to convince any one who has ever seen a Wimshurst that the two machines are essentially different. As to the principle involved, they, as well as all other influence machines, are based upon Nicholson's "doubler."

In this connection it may be interesting to state that a series of measurements has been made for the purpose of comparing the quantity of electricity developed respectively by a Voss and a Wimshurst machine provided with plates of equal diameter, the result showing that the latter yields three and a half times as much as the former.

The machine which is pictured above was exhibited at the recent Royal Society conversazione. It attracted considerable attention, as did also the photographs of the spark discharge.

TOWN ELECTRIC LIGHTING IN FRANCE.

BOURGANEUF, a small town in the middle of Creuse, has just adopted electric lighting, with every prospect of complete success. The example thus set will, no doubt, be followed in many places where the conditions laid down by M. Ernest Lamy, the projector of these installations, can be observed. The system is suitable for those towns that are not already lighted by gas, and is worked by hydraulic power, available during the day for various industries and during the night for lighting.

Contracts for lighting are made by M. Lamy with these little towns similar to those made for lighting by gas, for a period of 40 to 50 years, he undertaking municipal lighting and the lighting for private consumers as far as the power at his diposal will allow. The public lighting is supplied by contract, that of private persons is rated by the meter.

The lighting of the town of Bourganeuf comprises, besides 60 street lamps, the entire lighting of the town hall, with 20 lamps; the church with 7 lamps; cafés, hotels, shops, &c., amounting to about 106 lamps, the installation being capable of maintaining about 300. The working of the system is in the hands of M. Marcel Misme, mill owner.

The motive force is produced by an old trough wheel 5 metres in diameter, making only 6 revolutions per minute. This primitive motor is disadvantageous for a fall of about 11 metres, but with a suitable turbine capable of working the machine direct it would be easy to obtain the 25 to 30 H.P. necessary for the

* "Electricity Treated Experimentally," by L. Cumming, M.A.

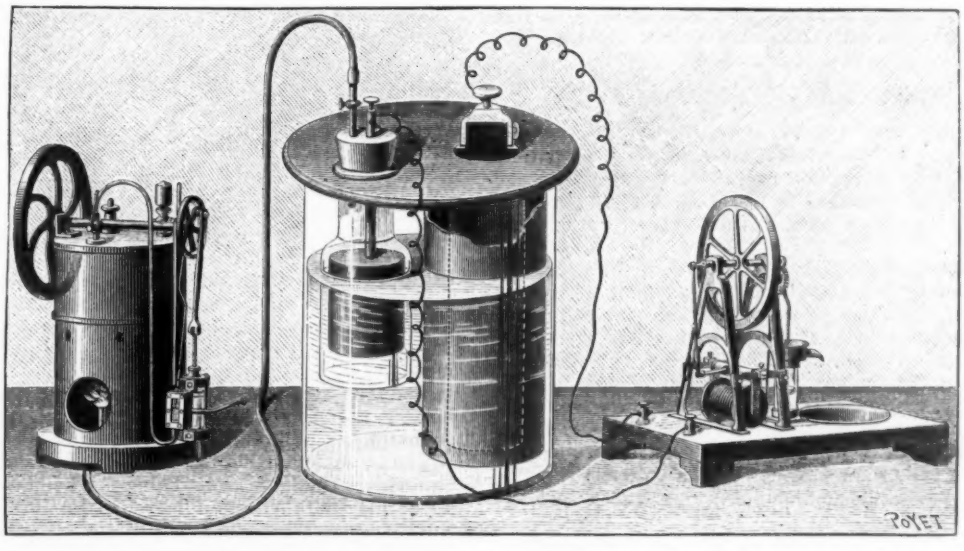
complete installation. This improvement will soon be made.

The current is supplied by a Thury dynamo machine with 6 poles, compound wound, running at 450 revolutions per minute and giving normally 110 volts at the terminals and 180 ampères, but capable of giving as much as 225 ampères without danger. The wires are overhead, and laid on insulators.

The lamps are all on the Woodhouse and Rawson system, 10 candle type, requiring, according to the distance from the works, a distance amounting to 1,750 metres for the farthest lamp, from 80 to 90 volts and about 0·3 ampères. These low power lamps certainly facilitate the distribution, and this installation will furnish some useful information as to the duration of these lamps when in service. The public lamps are all lighted when the dynamo is started and only extinguished when it stops. The fittings are very tasteful and the lamps ingeniously distributed so as to give a satisfactory light with the least possible number.

THE TRANSFORMATION OF PHYSICAL FORCES.

ONE of our readers in Monte Video, says *La Nature*, M. E. Paccard, sends us a description of an arrangement of Bunsen battery by means of which he carries out a very curious experiment upon the transformation of physical forces. Our illustration shows the arrangement.



Let us first examine the construction of the battery. The zinc, instead of being formed of a cylindrical plate surrounding the porous pot, is a single massive cylinder, suspended under a bell glass, fixed itself to a cover of wood which hermetically closes the whole system by means of wax or mastic.

The bell glass passes through the cover; it is closed by a stopper of India rubber with two tubes. Through one of these tubes passes a copper rod which supports the zinc and which serves as an electrode. The other tube is provided with a cock which allows the hydrogen gas formed to escape. This cock, when opened or closed, opens or closes the circuit. In fact, in the first case the hydrogen escapes, and in the second, having no means of issue, it accumulates in the bell and forces out the liquid: the battery ceases to act as soon as the zinc is uncovered.

At the side of the bell just described is placed in the ordinary way the carbons and the porous pot containing the nitric acid.

The experiment is conducted as follows: the wires fixed to the two terminals are connected with a small electric motor which is seen on the right of our illustration and which works as soon as the contact is established. The hydrogen disengaged is, on the other hand, conveyed by means of an India rubber tube under the boiler of a small steam engine shown to the left of the engraving. The gas is ignited, the water soon boils, and the engine begins to act.

We have thus at the same time a generator of heat and of electricity: it is a beautiful experiment which we recommend to physicists.

ON THE TRANSFORMATION OF HEAT INTO ELECTRIC ENERGY.

ACCORDING to the law of the conservation of work as applicable for all natural processes, writes W. Peukert, in *Central Blatt für Elektrotechnik*, we regard the electrical energy furnished by any source of a current as the equivalent of some other form of energy which is transformed into electricity by the action in the source of the current. In the above-named, hitherto most usual sources, it is fundamentally heat which undergoes such a transformation and is converted into electricity. In galvanic batteries it is the heat produced in them by chemical processes which is converted into electricity; in the thermo-piles there is a direct transformation of heat, which is conveyed as such to the several soldered joints of the elements into electricity. Even the energy furnished by dynamo machines can be regarded as produced from heat, only the heat conveyed to the motor of such a machine (in case of a steam or a gas engine) undergoes an intermediate transformation into mechanical energy which, when passed into the dynamo, is converted into electric energy.

From this point of view it is certainly an interesting question what percentage of heat is converted into electricity by the above-named sources of currents. It is the object of this memoir to carry out such an inquiry. We will firstly, without reference to cost, consider the proportion of transformation between heat and electricity from these various sources, and afterwards discuss the economic phase of the question. In order to allow of a more ready comparison we will consider only that portion of the total electric energy of a source which is available as utilisable work at the terminals and study its ratio to the heat consumed.

A.—*Galvanic Combinations.*

Of these we will consider only the Daniell and the Bunsen, as in both these not only have the chemical

processes been accurately determined, but numerical data are at hand both for the developments and the absorptions of heat thus produced.

For Daniell's battery the chemical process may, as it is generally admitted, be represented by the following symbols :—

$$+ (Zn\,SO_4) - (H_2\,SO_4) + (H_2\,SO_4) - (Cu\,SO_4)$$

There is first formed sulphate of zinc; the heat thereby liberated is per equivalent of zinc (32·45 grms.) 54,191 gramme calories. The simultaneous decomposition of sulphate of copper represents per equivalent (31·58 grms.) a liberation of heat of 27,822 gramme calories; we obtain, therefore (the two other processes formation and decomposition of sulphuric acid mutually annulling each other) as the algebraic sum of the quantities of heat (which, since they do not appear as such, may be called heat mutations), 26,369 gramme calories.

If we now determine the maximum electric available work which we can command by means of a Daniell battery, we obtain this when the external resistance is equal to the internal resistance; hence we obtain, if we assume the electromotive force as 1·088 volt and the internal resistance as 0·24 ohm, 1·233 volt-ampère as the maximum effect. This corresponds to a quantity of heat of 0·296 gramme calories. The above-given sum of the heat mutations represents the solution of an equivalent of zinc or the precipitation of an equivalent of copper; to a current of the intensity = 1 A there correspond per second 0·00001038 equivalents; as in the present case we have in the circuit a current of the intensity 2·266 A, the heat necessary for maintaining this will be per second

$$0{\cdot}00001038 \times 2{\cdot}266 \times 26{,}369 = 0{\cdot}6202$$

gramme calories.

If we compare the heat thus consumed with that equivalent to the electric useful work we find that of the entire heat consumed in the element 47·72 per cent. is available in the external circuit in the form of electric energy.

An analogous calculation may be carried out for the Bunsen battery, but not with the same certainty as for the Daniell, since we have not such trustworthy data for the formation of heat which occurs during the decomposition of nitric acid; still the result obtained gives us a notion as to the utilisation of the heat in this battery.

If we indicate a liberation of heat with + and an absorption of heat with − we obtain the following scheme for the process in the Bunsen battery:

$$+ (Zn\,SO_4) - (H_2\,SO_4) + (H_2\,O) - (ON_2\,O_4\,H_2\,O).$$

On substituting the quantities of heat corresponding to all the several processes, we obtain as the algebraic sum of all the mutations of heat

$$54{,}191 - 46{,}462 + 34{,}450 - 5{,}010 = 37{,}169$$

gramme calories.

We assume the electromotive force of the Bunsen element as 1·9 volt, the internal resistance as it appears in large elements 0·06 ohm; we have then for the maximum electric available work the value 15·039 volt-ampères, to which corresponds a heat of 3·611 gramme calories. According to the assumption made for the constants of the element there circulates here a current of the intensity of 15·83 ampères; the heat consumed in the element per second for its maintenance is found according to the calculation made in the case of Daniell's element as 6·107 gramme calories, of which in this case 59·1 per cent. are available in the outer circuit.

B.—*Thermo-piles.*

We shall here consider merely those thermo combinations whose constants are accurately known, and for which the consumption of gas or fuel has been determined. For the best verified Rebicek's thermo-piles we make use of the values which H. Kayser has ascertained. A star-pile of 20 elements had an electromotive force of 1·92 volt with an internal resistance of 0·717 ohm. The consumption of gas per hour was 90 litres. For the maximum electric available work we obtain in this case 1·2845 volt-ampères, whilst the equivalent quantity of heat is 0·3085 gramme calories. If we calculate the quantity of heat evolved per second by the combustion of 90 litres of gas, taking the weight of a cubic metre of coal gas as 0·696 kilos. and its combustion heat per kilo. as 10,600 calories, the heat required per second for warming the thermo battery is found to be 184·44 gramme calories. Of this heat 0·3085 calorie, *i.e.* 0·16 per cent., are available in the outer circuit.

For a star battery of 25 elements with an electromotive force of 2·06 volts and an internal resistance of 0·774 ohm, the hourly consumption of gas was 100 litres, and consequently the heat evolved per second 204·933 gramme calories. From the constants of the battery there appears the maximum effect as 1·369 volt-ampère, representing 0·329 gramme calories, so that here again 0·16 per cent. of the heat consumed is available in the outer circuit.

A Rebicek thermo battery, of the large type, having an electromotive force of 4·321 volts and a resistance of 0·778 ohm developed with an hourly gas consumption of 540 litres a maximum effect of 5·998 volt-ampères, representing 1·44 gramme calories. The consumption of heat per second amounts to 1,106·64 gramme calories, of which 0·13 per cent. can be utilised in the outer circuit in the form of electric energy.

For a similar examination of Clamond's thermo-piles we take, firstly, from Müller-Pfaundler's "Lebruch der Physik" (Vol. III. p. 607) the following data :—A Clamond battery of 100 elements consumed hourly 230 litres of gas and had an electromotive force of 2·07 volts and an internal resistance of 0·943 ohm. The maximum effect attainable is 1·135 volt-ampère, representing 0·2727 gramme calories. The heating of this battery required per second 471·346 gramme calories, of which, therefore, only 0·057 per cent. is transformed into available electric energy.

H. Kayser gives the following values for a Clamond battery which he examined: — electromotive force = 6·1 volt, internal resistance = 4·07 ohm, consumption of gas 350 litres hourly. The maximum useful effect of this battery is therefore 2·285 volt-ampères representing 0·549 gramme calories. The battery consumed per second 717·266 gramme calories. In this battery, therefore, only 0·076 per cent. of the heat consumed is available in the exterior circuit.

The transformation ratio of these thermo-electric batteries is the more remarkable as it had been assumed, apparently with a certain degree of justification that in these sources which effect a direct transformation of thermic energy into electric energy we should find the most rational utilisation of heat, and there has been ascribed to them an especial practical importance for the future. The figures obtained do not give the transformation coefficient of thermo-electric alloys and do not allow of an opinion as to its magnitude, which may be more considerable than is commonly supposed. They show merely, that of the heat evolved by the combustion of the fuel only a small portion is rendered serviceable for the purpose intended, since the surfaces to be heated have only a trifling extent, on account of the small section of the elements which often, in addition, carry polar appendages. The heat issuing into the air from the lateral surfaces of the elements does not undergo the maximum of utilisation of which it is capable on conversion into electricity. From this point of view we may understand the more considerable value of the transformation ratio of Rebicek's star batteries as compared with those with a straight line of fire, because in the former unnecessary losses of heat are somewhat obviated by the plate of mica resting on the heating plugs, thus rendering the heating more economical.

The above-mentioned experiments of H. Kayser also indicates a more rational utilisation of the fuel in Rebicek's batteries than in those of Clamond. They

show for the intensity of the current, if the circuit is closed without resistance, calculated per litre gas, a mean value of 0·03 in Rebicek's batteries and in those of Clamond only 0·005.

A more favourable proportion than the batteries just described is shown by that of Clamond, heated with coke. When the hourly consumption of coke is 9 kilos the battery has an electromotive force of 218 volts and an internal resistance of 31 ohms. If the heat of combustion of coke is assumed as 7,100 calories per kilo. we obtain a useful electric energy of 0·518 per cent. of the heat consumed.

We will now, with reference to the utilisation of the heat in a thermo battery, compare it with a heat engine and raise the question how much electric energy is yielded by the heat consumed in a thermo battery if it is first converted into mechanical energy by a heat engine, and transferred by the latter into a dynamo machine.

As is well known, we obtain the available work of a heat engine by the formula

$$L = \frac{Q\,(T_1 - T)}{A\,T_1},$$

where Q is the heat received and T_1 and T the absolute temperatures between which the cyclical process is carried on. In order to have the most closely similar conditions, assume, also, for the thermo batteries that here, as in heat engines, only 50 per cent. of the total heat of combustion is made available. For Rebicek's thermo batteries we can put approximately the temperatures of the heated and cooled junctions as 600° and 50°, so that $T_1 = 600° + 273° = 873°$, and $T = 50° + 273° = 323°$.

We here obtain, certainly, for T_1 a temperature higher than the limit temperature in heat engines, in which the upper limit may be taken as 573°. But in spite of this circumstance the result obtained will allow of at least an approximate estimate of the transformation of heat by thermo batteries. If we put for Q in the above formula 0·0922 kilo. calories, according to the statements for the star battery of elements, we obtain as available work of the heat engine

$$0{\cdot}0922 \times \frac{550}{873} \times 424{\cdot}5 = 24{\cdot}65 \text{ metre kilos.}$$

We assume the degree of action of the heat engine as 0·5, so that we have 12·32 metre kilos. as the work transferred to the dynamo. If we suppose a direct transfer, so that no further losses have to be taken into consideration, and put the transformation ratio of the dynamo as 0·68, we have then an electric useful work of 82·18 volt-ampères, or, in round numbers, a value 64 times greater than the maximum effect of the thermo battery.

If we use the values for the two other Rebicek batteries above mentioned, we obtain by a similar calculation the figures 67 and 82.

Supposing that the same temperatures are reached in Clamond's battery heated with coke, we obtain for this battery the figure 20·6, *i.e.*, by means of a heat engine which carries on a cyclical process within the same temperatures, a dynamo would yield about 21 times more electric energy than this thermo battery.

In a similar manner Lord Rayleigh has compared a thermo-electric battery (consisting of nickel silver and iron) with a perfect heat engine and has found that the latter for an equal outlay of heat would yield 300 times more electric energy than the thermo battery.

These figures make it plain that thermo batteries, as hitherto constructed, are very far from effecting that rational conversion of heat into electricity which we are often inclined to assume, and that, on the contrary, they are far surpassed by dynamo machines driven by steam or gas engines. They must undergo very essential modifications and improvements before they can become capable of competing with the latter.

C.—*Dynamo Machines.*

As the motor of such a machine, we assume here a steam engine or a gas motor, and we must compare the electric energy supplied by the dynamo (in order to have the same conditions as in case of the other sources of currents) with the total heat yielded by the fuel, coal, or coal gas. It is not admissible here to consider merely the heat actually supplied to the boiler, and to take the available work thence resulting as a basis for further discussion, since the question is not the degree of effectiveness of the motor. We have to consider that the combustion heat of a certain quantity of fuel yields, after an intermediate transformation, a certain electric energy to the dynamo machine.

If we allow for the steam engine per hour and per horse-power a consumption of 1·8 kilo. coal, and take the combustion heat of coal as 7,500 calories per kilo., the heat liberated per second is 3,750 gramme calories. If we further suppose that the mechanical energy furnished by the steam engine is communicated without any loss to the dynamo, whose ratio of transformation is taken as 0·68, we obtain per second an electric energy of 500 volt-ampères, representing 120·07 gramme calories. By comparing this heat with that supplied by the fuel, we find that 3·2 per cent. of the latter is transformed into available electric energy.

If the motor is a gas engine, such as Otto's, which uses one cubic metre of gas hourly per horse-power, the heat consumed in a second would be 2049·3 gramme calories, of which, on the suppositions made above 120·07 calories, *i.e.*, 5·85 per cent., are made available by the dynamo in the form of electric energy.

We have thus far determined the proportion of the transformation of heat by the various sources only in a theoretical manner, and we have found that in this respect galvanic batteries permit of the most rational utilisation of heat, since, in comparison with the heat consumed, they furnish about ten times more useful electric work than dynamos; and if we disregard the Clamond thermo-pile heated with coke, more than 200 times as much as thermo-electric batteries.

The conditions are altered when we take also the cost into consideration, the heat consumed in galvanic batteries being the dearest, since here zinc is burnt, whilst in the other sources coal or coal gas is used as fuel. We will therefore ascertain the cost price of a given quantity of useful electric work, as furnished by the above-named sources.

D.—*Calculation of Cost.*

In order to have the same conditions in all cases, we will undertake to determine the cost per hour of electric useful work of 500 volt-ampères, as furnished by galvanic batteries, thermo-piles, and dynamos.

If we retain the assumption made for the constants in Daniell's element, we find that 406 elements are required to give 500 volt-ampères. As we have a current of the strength of 2·266 ampères, it follows that one ampère precipitates per second 0·00001038 equivalent of zinc; hence the hourly consumption of zinc per element is 2·7477 grammes, or for the entire number of the elements, 1115·57 grammes. If we take the price of 1,000 grammes of zinc at 0·5 mark (about 6d.) the cost of the zinc consumed is 0·558 mark.

The sulphate of copper used in the element need not be considered, as it is covered by the value of the copper precipitated. But the consumption of sulphuric acid must be noticed, which is only in part supplied by the dissolved sulphate of zinc. In order to dissolve 1115·57 grammes of zinc (taking the equivalent of sulphuric acid as 49, and of zinc 32·45), there are required 1684·52 grammes of sulphuric acid, which, taking 1,000 grammes (1 kilo.) at 0·3 mark, costs 0·505 mark, so that the entire cost of the Daniell batteries is 1·06 mark (slightly over 1s.). It must be remembered that we have here included neither a repayment of the first outlay, nor the labour required for attending to so large a number of elements.

We will also determine the cost of the material consumed in Bunsen's batteries, for which we have the following data. To yield a useful electric work of 500 volt-ampères, we require 34 elements if we assume the constants of the elements as above. As the strength of the current is 15·83 ampères, the hourly consumption

of zinc per element is 19·195 grammes, or, in the total, 652·63 grammes, which cost 0·326 mark. The consumption of sulphuric acid, 985·48 grammes, costs 0·296 mark.

We have still to determine the nitric acid consumed and find this as 1,267·04 grms., as 32·45 grms. zinc represent 63 grammes nitric acid. If we take 1,000 grms. at 0·7 mark, the nitric acid costs 0·887 mark. Thus the total costs for the Bunsen battery, exclusive of first outlay and labour, is 1·51 marks.

As for the thermo batteries, if we use Rebicek's 20 element star batteries, 500 volt-ampères cost hourly 5·55 marks, or with 25 elements, 5·78 marks. Here, also, the repayment of first outlay is not included.

For the 50 element battery the hourly cost for 500 volt-ampères is 7·17 marks, and for Clamond's battery it even reaches 16·03 marks.

In Clamond's battery heated by coke, the working cost is about 0·42 mark without reference to first cost and depreciation, on which latter point no assumption can be made, as we have, so far, no experience as to its durability.

In computing the cost for dynamos we will make use of the communications of Prof. Pfaff concerning the price of the motive power. According to him the total working cost (inclusive of 10 per cent. as depreciation of the capital sunk, attendance, &c.) for one horse-power hourly when a fixed 50 horse-power engine is used with precision gearing and condensation, is 9·5 pfennige (10 pfennige = 1d. English), taking 3,000 working hours yearly.

If we calculate for the cost of the dynamo, its erection and arranging the transmission in round numbers 15,000 marks (£750) at 10 per cent. interest hourly per horse-power and 3,000 working hours yearly, the quota of depreciation is 1 pfennige, so that the total hourly costs for 500 volt-ampères are 10½ pfennige.

With an 8-horse gas motor under the same conditions, the hourly cost per horse-power is 23·16 pfennige. If we assume this price higher by 2 pfennige, we find then, with a depreciation of 10 per cent. for first cost and installation of the dynamo, the sum of 4,800 marks (£240), by which the above-named costs appear to be covered, so that in this manner the hourly cost of 500 volt-ampères comes to 25·16 pfennige. This price would come lower if the calculation were made for a more powerful motor.

For the sake of a ready comparison we will here collate the above results. An hour's electric work of 500 volt-ampères costs if produced by

		Marks.
Daniell elements		1·06
Bunsen		1·51
Rebicek thermo	star battery	5·65
	straight line	7·17
Clamond's thermo	with gas	16·03
	with coke ...	0·42
Dynamo, driven by steam		0·105
„ „ „ gas		0·25

These figures show that the cheapest source of electric energy is yielded by dynamos driven by steam-power. Their striking superiority over the other sources of electric currents would be still more striking if in these also the cost of production were taken into account.

Electricity in the Royal Navy.—The *Mosquito* gunboat, at Devonport, having been selected by a committee, consisting of Captain Sir George Nares, Sir James Douglas, and Captain Nisbet, for service as "light vessel," is to be fitted with the electric search light. She will be movable from one part of the coast to another at a distance of from 300 to 400 miles. The *Jackal*, armed tug, which will shortly leave Plymouth for the Scottish coast, adjusted her compasses a few days since in the Sound, when under the superintendence of Commander E. W. Creak, of the Admiralty, experiments were made as to the effect of the electric light dynamo working on the compasses.

INCANDESCENT LAMP PATENTS.

EDISON *v.* WOODHOUSE AND RAWSON
AND
EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY *v.* WOODHOUSE AND RAWSON.

(*Before* MR. JUSTICE BUTT, *sitting for* MR. JUSTICE NORTH.)

(*Continued from page* 476.)

Tuesday, May 11th, 1886—(continued).

DR. JOHN HOPKINSON, examined by Sir Richard Webster: Lane-Fox's lamp, described in specification 4,626, was not a practical lamp; it was less practical than other attempts which have been made in the same direction. In his final specification the part relating to the combination of the carbon conductor and mercurial float is left out.

Sir RICHARD WEBSTER: Now one question on the provisional specification of Scott, No. 861, of 1878: "When sticks or rods are to be made, they may either be made in the same way, or they may be made by forcing the plastic mass through a hole in a draw plate, or they may be made, when cylindrical in figure, by rolling portions of the plastic mass on a flat surface, or by the action of grooved rolls. . . . . My invention consists secondly in manufacturing flexible bands, ribbons or cords of carbon (or mixtures consisting essentially of carbon) to be used as hereinafter described in the production of light by electricity. I take the carbon or carbon mixture and incorporate therewith fibres of asbestos or fibres of hemp or other material or organic fibre, together with adhesive matter as hereinbefore explained. By rolling or otherwise I form the mixture into long bands, strips or ribbons, and dry them by heat. When the fibres are mineral the heat applied may be sufficiently high to decompose the flour or starch paste, but when organic fibres are employed the heat must not be so high as to decompose the said fibres." Does that description in any way indicate a filament of the same kind, or made in the same way, as Mr. Edison describes?—Certainly not; and the distinction is brought out exceedingly clearly by Mr. Edison, if you take the last sentence which you read: "But when organic fibres are employed the heat must not be so high as to decompose the said fibres," and compare it with what Mr. Edison says about enclosing it in a chamber and subjecting it to a high heat.

Look back three lines, at the beginning of page 2: "The articles thus produced may be coated with copper, applied as copper bronze, or deposited by electricity, or may be coated with plumbago, the said coatings having for their object to make the articles better conductors of electricity." Does that point to arc lighting?—I think that is what he is addressing himself to. He wants to get a flexible conductor for arc lighting.

Mr. JUSTICE BUTT: But will you go on: "My invention consists, thirdly, in making sticks, blocks, or pieces of carbon moulded from the plastic mixture herein first described of such a figure that when fixed close together upon a flexible band they show when the band is passed over a pulley," &c. Why is not a stick made of carbon moulded from a plastic mixture something like Mr. Edison's filament?—The manufacture of the sticks from a plastic material—mixtures of powdered coke and molasses, and so on—by moulding them and pressing them and heating them in closed retorts, was very old. It had been in constant use for the manufacture of carbons for arc lights for I dare say 30 years before. The process undoubtedly has a considerable resemblance. I think the whole of this specification is for arc lighting.

Mr. CHARLES admitted that Scott's object was an arc light.

Sir RICHARD WEBSTER: Is there the slightest indication of a conductor to be carbonised after it had been formed here?—No.

It is blocks or paste, or sticks of carbon which are to be put upon a flexible band, which is made a conductor by having the sticks of carbon put upon it?—I should correct that last answer, I think.

Mr. CHARLES: They are carbonised in Scott's after they are formed.

Sir RICHARD WEBSTER: I think it is not so.

WITNESS: I am not quite sure, I should have to refer to the specification again, as to whether it was possible he had in any way suggested using plastic materials and then carbonising.

Sir RICHARD WEBSTER: I protest that it is not material, but I have no objection to taking my friend's view for a moment. Is there anything in the specification which in any way describes Mr. Edison's arrangement of carbon filament or its production?—Clearly not. There is no limit of carbon filament. It is perfectly clear this is arc lighting throughout.

Mr. JUSTICE BUTT: Yes, I think that is absolutely clear from the language. There is a portion of the specification which speaks of making hollow cylinders of the plastic mass and apparently making it of a mass which is not carbon, and then converting it into carbon, or what they describe as a substance composed of nearly pure carbon afterwards. The suggestion as I I understand it here is, no matter whether for an arc or any other lamp, that you have a conductor of some sort made of a substance which is not nearly pure carbon converted after manufacture to that which is pure carbon.

Sir RICHARD WEBSTER: Of course, your lordship knows already that our case is that even if that be the meaning of this, it is no anticipation in any way of our own patent. [To witness]: Do you understand that those hollow cylinders there described either

have or would have the same electrical functions as the filament conductors of Mr. Edison?—Clearly not. There is no resemblance in their electrical functions.

Now I will call your attention to the specification of Mr. Charles Weightman Harrison, No. 3,470 of 1878: "My invention relates secondly to the production of flexible carbon or flexible metallised carbon burners of any required thickness or length. This I effect by using threads or filaments of silk, cotton, or other suitable flexible material, which I first treat with acid, such as nitro-sulphuric acid, to render it more perfectly combustible, and then coat with carbon or metal by rubbing, pressure, or otherwise incorporating with them powdered plumbago or other carbon, or with metal compounds by electrotype or other process, and then form such coated or treated strands into a cord or rope of any required dimensions." Do you find anything there describing either Edison's conductor or the mode of preparing it?—No. He does not seem to address his mind at all to the production of a conductor of small cross-section.

Does that relate to arc lighting?—Yes, I believe it does throughout; and at line 35 it is clearly the arc which he is referring to.

Mr. JUSTICE BUTT: The more important matter to my mind is this: there is nothing describing a conductor of small cross-section?—No, there is not; it must have been a conductor of very considerable cross-section.

Sir RICHARD WEBSTER: He proposes to act upon it with acids, such as nitro-sulphuric acid. What would that make?—You would get a compound of cellulose, or whatever the organic matter was, with the nitrogen and oxygen of the nitric acid.

That would not be a very useful light?—It contains within itself the elements of its own destruction. As soon as it reached a certain temperature, the compound being exceedingly unstable, there would be a sort of mild explosion. There would be a change and then combustion would occur. There would be an end of the filaments. He proposes to burn out the filaments and leave the rest, as I understand.

Would the giving of these descriptions lead anybody to make the combinations as described by Edison?—No, certainly not.

Mr. JUSTICE BUTT: Neither any of them nor the whole of them together?—No, I do not think they would help him at all.

Sir RICHARD WEBSTER: Did you ever see or hear of any practical commercial carbon incandescent lamp prior to Mr. Edison's specification?—No.

Had arc lighting before 1879 arrived at a very fair point of efficiency?—Yes; for a large variety of purposes.

They had been used to light public places, for instance?—Yes; for many places. The Jablochkoff candles were used on the Thames Embankment before 1879.

Had the fact that a small sub-divided lamp was required been engaging the attention of the electrical scientific world for a very considerable time?—Yes. Many people had the impression that it was a thing which could not be done. Mr. Edison and Mr. Swan were both known to be working upon it.

Now I will ask you one or two questions about Swan's lamp. Is this (hands lamp to witness), or is it not, the same as Mr. Edison's combination?—No. I should not call that a filament.

In your opinion was that carbon before it was formed into shape?—I should think so. I should think it has been reduced.

Would it indicate a low resistance?—Yes. I should guess it to be between one and two ohms resistance, perhaps not exceeding one ohm. The platinum conductors also correspond with the view of such a resistance; they are very much stouter than would be used in an incandescent lamp at the present day.

Do you believe it was made in accordance with Mr. Edison's specification?—No, I do not.

Given that lamp put into the hands of a workman to make a lamp, would that lamp be, in your opinion, any guide to him to produce the combination which you find described, and which you yourself have explained as shown in Edison's specification?—No; in my judgment it would not be, inasmuch as it neither gives a hint of a filament nor of a mode of manufacturing a filament.

That lamp was shown in December, 1878. As far as you know, did it ever go to any practical result beyond the production of that lamp?—Not that I know of. As far as I know it was regarded purely as a scientific matter of interest, but not of any commercial importance whatever.

It was not patented?—No.

And led to no further step in the development of the science?—No.

We will now pass to Swan's patent, No. 18 of 1880. What do you find to be the invention described in that specification?—Mr. Swan first points out the difficulties which his invention was required to obviate, evidently referring to incandescent lamps, possibly similar to the one I have just been looking at. What he says the difficulties were are these:—First of all that the carbon conductor, as used, gradually wasted and ultimately broke. That, in fact, was no doubt due to two causes. One of those causes was a kind of wasting by residual gas, no matter what that residual gas might be; the other, no doubt, was due to the fact that carbon is combustible, and that in the residual gas there would be oxygen, and the carbon would combine with that oxygen, forming carbonic acid or carbonic oxide, which would again break and deposit the carbon elsewhere, or at all events would reduce the carbon and cause a degree of waste. The second evil was this, that owing again to the presence of a certain quantity of gas the interior surface of the globe became blackened or dulled. Then he addresses himself to removing those defects, and the way in which he does it is by perfecting the vacuum. The cause of the imperfection of the vacuum was the gas occluded by the carbon escaping out, and he obviates the evil by heating the carbon electrically to as high a temperature as, or a higher temperature than, would ever be used, and at the same time exhausting the gases so driven out, and, finally, in order to render the state of things permanent, he seals the globe.

Before asking you as to the novelty of that I think it only right to call your attention to No. 2,402 of Edison's. What sort of a lamp was Mr. Edison describing there?—He was there endeavouring to make an incandescent lamp in which the conductor was platinum or platinum iridium.

And in order to improve that lamp what does he disclose?—He finds that platinum or platinum iridium, if suddenly heated to a high degree of incandescence, develops cracks in the surface, and he attributes that result to the presence of occluded gases suddenly bursting forth, owing to the high temperature. He proposes to obviate that by first of all heating the platinum or platinum iridium to a comparatively moderate temperature in vacuo, and exhausting any gases driven off from the receiver in which it was placed; then heating it again to a higher temperature, and again exhausting or continuing the exhaustion, and so on, until the platinum attained an exceedingly high temperature; and in that way, he says, he alters the character of the platinum in a very great degree.

Was Edison's object to improve the platinum or to improve the vacuum?—His main object was to improve the platinum, undoubtedly; that is the prominent thing that he throws forward.

Referring to the passage: "Carbon sticks may be also freed from air in this manner, and be brought to a temperature that the carbon becomes pasty, and if then allowed to cool, is very homogeneous and hard," you understand that homogeneous and hard as referring to the substance of the carbon, I suppose?—Clearly.

What do you understand to be the object of the treatment of the carbon sticks there?—As I understand this, having explained the physical facts upon which he bases his invention, he goes on to tell us, as another interesting physical fact, that carbon may be treated in the same way; but I see no indication that he proposes any practical application of carbon so prepared.

Mr. JUSTICE BUTT: Then it ought not to have been here, in fact?—I have often seen in specifications interesting physical facts put forward to which no claim has been made.

Sir RICHARD WEBSTER: At any rate, its importance is with reference to the homogeneity and hardness of the carbon, and not of any air or vacuum surrounding the carbon?—No; he refers there to no question of vacuum.

Do you think that would be an indication to any electrician that an electric lamp with a carbon conductor would have its vacuum improved by that treatment?—It is difficult to say how far it might be suggested to his mind; but it certainly calls no attention to the fact that carbon is acted upon by the residual of gas in a different manner from platinum.

The second claiming clause is: "The method herein described of preparing metals and metallic conductors for electric lamps or burners, consisting in freeing the metallic conductors of gases in a vacuum, and then hermetically sealing the surrounding air-tight transparent case, substantially as specified." Given Swan's specification, and, of course, Edison's later specification, 4,576, not to be existing, and assuming that in December, 1879, anybody had thought to make an incandescent lamp with a carbon conductor in it, do you think Edison's specification 2,402 would have led them to have exhausted under an electrical current with a view to improve the vacuum?—It is possible it might have been suggestive in that direction.

Until Swan's publication in England in that specification, you know of no publication of the desirability of it as applicable to a carbon lamp?—No.

Is it easy sometimes to read specifications in the light of subsequent knowledge in a way in which they would scarcely be interpreted without?—The greatest difficulty is, in reading a specification many years after its date, to carry one's mind back to the state of knowledge at the time when that specification was first filed.

With regard to Gimingham's patent, I do not think you yourself have broken a Woodhouse and Rawson lamp or examined the junction?—No; I have made no further examination than was possible through the glass.

I will only ask you, then, as to the subject matter of novelty. It consists, as we know, of flattening the platinum into a spade-like shape, and turning it round into a socket and putting the carbon conductor in. Do you find anything like that in any previous specification?—No.

By virtue of this socket, could you get a longer length of the carbon in contact with the metal of the platinum?—Yes; you get an extended contact of the two bodies.

Do you think it would require thought, research, and experiment to think out such an arrangement, in the first place?—It would certainly require thought. The thing is simple, and I think beautiful, from its simplicity.

Cross-examined by Mr. CHARLES: But still, is it not the adaptation of an ordinary mechanical device to join the platinum and the filament?—I do not recall any similar mechanical device precisely. I daresay they may exist, but I do not recall them at this moment.

Now, with regard to the other patents, do I understand you that prior to Edison's patent the filament was not shaped before carbonisation? I mean that the knowledge that the filament could be shaped before carbonisation was not in existence before Edison's patent?—That was new, I think, at Edison's time.

Let me draw your attention to a passage from M. Sidot's lecture on the "Action of Carbon Disulphide and Carburetted Gases on Wood Carbon," the date of which is March 21st, 1870: "In a preceding work I have shown that carbon disulphide was decomposed by carbon, that this last increased in weight, and that sulphur was set free. In following up these enquiries, I had examined what effect carbon disulphide has on certain organic bodies of nature both vegetable and animal. I introduced into a porcelain tube little pieces of wood, across which I began by passing the vapour of carbon disulphide in a cold state in order to expel all the air of the tube. This first result being obtained, I heat the tube slowly and gradually up to a red heat for the space of about an hour. When it has cooled, we find in the tube sticks of a carbon differing in their physical properties from ordinary carbon. The substances of the most different woods, such as box, ash, elm, lilac, alder and cork, can make this new carbon. What especially distinguishes it is its ringing sound, very like those bodies which are considered the most sonorous, such as steel, silver, aluminium, crystal, &c. I have the honour to submit to the Academy some specimens of these sonorous carbons. When we suspend one by means of a thread and strike it on the top it gives a metallic sound. Wishing to obtain with this carbon a sonorous effect, I turned a bell in ash wood and submitted it to the action of carbon disulphide according to the process which I have just described. This piece of ash has now become a bell, which I also present to the Academy; it gives out a sound similar to that of a metal bell of the same diameter. . . . . The same carbons, which are distinguished so completely by their elasticity from ordinary carbons, differ also from these last in their great conductibility for heat and electricity I believe that they would perhaps replace the carbons of the Bunsen battery. Pencils made from this give a much more intense electric light than that which we obtain from gas retort carbon. The carbon conductor becomes heated in the same manner as a metal and becomes gradually incandescent over its whole surface without breaking into a flame at any single point, like ordinary carbon. It becomes cool immediately we remove the heat. We can characterise its conductibility by saying that it is wood carbon transferred into coke. I have obtained similar results with thread, hemp, cotton, paper and silk. The carbon which I have obtained from wood possesses the metallic sheen, but this polish is only superficial. It has a greater density than wood carbon; it does not absorb gases more readily. I should observe with regard to this, that in heating the wood to a high temperature in a crucible filled with finely-pulverised wood cinders we obtain a carbon deprived of its absorbing properties and a much better conductor. Carbon disulphide is not the only agent of this remarkable transformation from wood into a carbon sonorous and conductive. Spirit of wood, carburetted hydrogen, &c., also change wood into carbon, elastic and conductive. Still more, I have proved that in passing the vapours of methylated alcohol over wood at a red heat in a porcelain tube, this vapour becomes decomposed, and at the same time the interior sides of the tube are covered with a very singular carbon. This carbon, in fact, presents itself in the form of filaments one centimetre in length, constituting a kind of silky and frothy coat, white, like silver. These filaments appear to be formed of little balls touching one another." First, to go back to the last paragraph but three, you see that this writer says he has obtained similar results with thread, cotton, hemp, paper and silk. Is not that a statement of similar results having been obtained from filaments before carbonisation?—What I understand there is that he proposes to heat these in a liquid or gas containing carbon and to deposit carbon upon them, at the same time carbonising them, no doubt.

Then he would shape them before carbonisation?—They would take some shape, no doubt.

And indeed he can select the shape they shall assume before carbonisation?—No doubt he could select the shape.

Mr. JUSTICE BUTT: Does he propose to carbonise these in the strict sense of the word; that is to say, to convert them into carbon?—No doubt the effect of the heat would be to reduce them to carbon, but at the same time you would deposit certain carbon upon their surfaces. To what extent he proposed to carry that is not disclosed.

Does he reduce the thing itself to carbon? That is the point.—Undoubtedly he would reduce the thing itself to carbon.

Mr. CHARLES: So much for Sidot. One word about Scott. It is quite true Scott's patent was for arc lighting, but is it not the fact that he, too, shapes the rods before carbonisation?—Certainly; he shapes objects and then carbonises them.

Now with reference to the word "filament." If I understood your answer to Sir Richard Webster, you do not consider that that substance inside the Swan lamp is a filament?—No.

Then do you confine the word "filament" to thin wire, a thinner wire than that, or what?—I am not prepared to say the precise dimensions at which a filament begins, but I understand the word "filament" to be used for the purpose of calling attention to the smallness of the cross section which is desired in comparison with the length.

Let me draw your attention to a lecture of Mr. Swan's, delivered at the Royal Institution in March, 1882, when Sir Fredk. Bramwell was in the chair. In that lecture occurs this passage: "It will be readily understood from what I have shown that it is essential to economy that the incandescing material should be able to bear an enormous temperature without fusion. We know of no metal that fills this requirement; but there is a non-metallic substance which does so in an eminent degree, and which also possesses the other necessary quality of low conductivity or high resistance. The substance is carbon. . . . . In the first incandescent lamp the vacuum was made by filling it with mercury and then running the mercury out so as to leave a vacuum like that at the upper end of a barometer. In the lamp subsequently proposed the air was exhausted by a common air pump. The invention of the mercury pump by Dr. Sprengel and the publication of the delicate and beautiful experiments of Mr. Crookes in connection with the radiometer, revealed the conditions under which a really high vacuum could be produced, and gave quite a new meaning to the word vacuum. It was evident to me that the whole incandescent carbon lamp experiments had not been made under suitable conditions as to vacuum; and that before condemning the use of carbon its durability in a really high vacuum required still to be tested. Strongly impressed with this idea, I proposed to Mr. Stearn, who was working on the subject of high vacuo, the carrying out of a course of experiments having for their object to ascertain whether a carbon filament produced by the carbonisation of paper and made incandescent in a high vacuum was durable. After much experimenting we arrived at the conclusion that when a well-formed carbon filament is firmly connected with conducting wires, and placed in a hermetically sealed glass bulb, perfectly exhausted, the filament suffers no apparent change even when heated to an extreme degree of whiteness. This result was reached in 1878. It has since then become clearly evident that Mr. Edison had the same idea, and reached the same conclusion as Mr. Stearn and myself. A condition of the higher vacuum found to be necessary was the simplification of the lamp. In its construction there must be as little material as possible, and especially there must be nothing in it capable of giving out gas of any kind. There must be no joints, except those made by the glassblower. Therefore, naturally and of necessity the incandescent carbon light took the most elementary form, resolving itself into a simple bulb, pierced by two platinum wires supporting a filament of carbon. Probably the first lamp having this elementary character ever publicly exhibited in operation was shown at a meeting of the Literary and Philosophical Society of Newcastle in February, 1879." It would seem, therefore, that Mr. Swan differs from you with regard to that piece of substance being a filament?—Possibly he may, but I am not absolutely clear as to what he means by this last passage.

Mr. CHARLES was proceeding to cross-examine with respect to this lecture of Mr. Swan's when

Mr. ASTON objected that this was not evidence, as it had not been proved that the words were those used by Mr. Swan.

Mr. JUSTICE BUTT: Assuming that those words were uttered by Mr. Swan, what question do you propose to put on them to this witness?

Mr. CHARLES: The question I propose to put is this: Having regard to the fact that the inventor describes that bar as a filament, what reason can you give for saying it is not one?

Mr. ASTON: I object on this ground, that the statement made by this gentleman in 1882 about what took place in 1878, and his view at that time as to what term should be applied to something, which, of course, he was very desirous of making out that he had invented, is no ground for asking.

Mr. JUSTICE BUTT: My impression, Mr. Charles, is that all you have a right to ask is this: "Have you read this? Assuming Mr. Swan to have said that, do you agree with it?" You have a right to read the passage, and say: "Do you agree with that, and if not, why not?"

Mr. CHARLES: I think that is what I did put. (To Witness): Will you give my Lord any reason for disagreeing with Mr. Swan's views?—I am not quite clear that Mr. Swan does mean to convey that that carbon in the lamp I have been looking at is a filament.

He calls it a filament?—I am not quite sure about that even. I take it he is calling emphatic attention to the fact that the bulb is entirely of glass. If he does mean to call that a filament then I disagree with him, certainly.

Mr. JUSTICE BUTT: "It is now found that carbon can be produced in the form of straight or bent filaments of extreme thinness." In seems quite clear to my mind that that is not a filament of extreme thinness in the lamp you have got.—Certainly not.

Mr. CHARLES: I do not say it is. But he says: "Probably the first lamp" (that is a simple bulb pierced by two platinum wires, supporting a filament of carbon) "having this elementary character ever publicly exhibited in operation was shown at a meeting of the Literary and Philosophical Society of Newcastle."

Mr. JUSTICE BUTT: It does seem to me he calls that very thing a filament.

Mr. CHARLES: Where do you stop calling a thin substance a filament? Is it a mere matter of degree?—Clearly, it is a matter of degree.

Mr. JUSTICE BUTT: I think the question we agreed upon was this: Mr. Swan calls that identical thing in the lamp you have before you a filament. Do you agree with him that it is properly called a filament?—Certainly not.

If not, why not?—Because the section is comparatively considerable as compared with anything I have ever heard the term filament applied to. There is no sensible degree of flexibility about it.

Mr. CHARLES: Then it becomes a question of degree?—Yes, certainly.

Mr. ASTON: Your lordship has a description of that identical conductor in the paper to which your attention was called before. In December, 1879, it was called a rod of carbon.

Mr. JUSTICE BUTT: That is a rod you may pickle until your time comes.

Mr. ASTON: The description given when the lamp was shown is more important than the description given in 1882.

Mr. JUSTICE BUTT: It is undoubted that Swan did call it a filament?

Mr. CHARLES: Mr. Edison himself describes the substance as filament, thread, strip, and wire. I think he uses them all. I am sure he uses the first three. Would you call that a strip (handing a large Edison lamp to witness)?—Yes, I think that would be a very good description of it.

I pointed out just now that M. Sidot had said that he could treat threads, paper, hemp, cotton, and silk, in the same manner as he treated the other substances he alluded to in the extract. There is another question I ought to have asked upon that extract. In the last paragraph he says: "I have proved that in passing the vapour of methylated alcohol over wood at a red heat, in a porcelain tube, this vapour becomes decomposed, and at the same time the interior sides of the tube are covered with a very singular carbon. This carbon, in fact, presents itself in the form of filaments of one centimetre in length, constituting a kind of silky or frothy coke, white like silver. These filaments appear to be formed of little balls touching one another." Is the method which he here discloses a practical method of getting a high resistance carbon?—Do you mean a carbon of high specific resistance?

Yes?—No; he distinctly says it has an exceptionally low specific resistance in an earlier passage: "The same carbons are as much distinguished by their elasticity from ordinary carbons, and are distinguished still more by their great conductivity for heat and electricity."

Is it not by virtue of the small sectional area that this carbon filament of Mr. Edison has a high resistance?—Yes; that is why I asked you whether you meant high specific resistance.

Could you not manufacture a filament similar to that and a filament of high resistance (not specific resistance) in the manner pointed out in the last paragraph of M. Sidot's paper?—I very much doubt it. I do not think you would get anything like uniformity. One of the points on which Mr. Edison lays stress, if I remember rightly, is that the filament should be tolerably uniform.

Could not the want of uniformity be provided against by preparation of it before carbonisation?—That I doubt, if carbonisation were conducted as here described. The carbonisation as here described must be conducted in disulphide of carbon vapour.

Now turn to Edison's patent, 4,576, page 5, claim 1: "The electric lamp for giving light by incandescence consisting of a filament of carbon of high resistance made as described and secured to metallic wires." Now I understand you to say that in your view that first claim is for the combination of the carbon filament of high resistance made as described, that is as before described, and secured to metallic wires as set forth?—Yes; for the particular purpose of forming an incandescent lamp.

Have you seen any of the plaintiff's lamps manufactured?—I have seen Mr. Edison's lamps manufactured.

Look at that other patent, No. 5,127. Do you see there that Mr. Edison, on December 15th, filed another provisional specification for an improvement in the process of manufacturing the carbon filament?—Yes.

Will you look at the mode in which he says he has secured that improvement in the process of manufacturing the carbon filament. He first of all makes use of paper, cuts it out, cuts a narrow strip in the form of an elliptical bow, and then treats a number of those pieces of paper in the bottom of a mould of wrought iron, laying a light weight on them in the form of a flat piece of gas retort carbon; he interposes tissue paper, closes the mould, raises the mould to 600 degrees, Fahrenheit, then allows the volatile portions of the paper to pass away, and at the same time the mould retains the paper in its proper shape. The paper is prevented from curling up, and then the mould is placed in a furnace and heated to a white heat, and then allowed to cool gradually. Is that the way in which you have seen the manufacture?—Not exactly. What I saw was the bamboo filament made.

Was the carbonisation conducted after a similar method?—There was a considerable similarity. There was a number of them packed into a comparatively small compass, so that a large number of filaments could be put into the furnace at once.

Now turn to the other patent. "Made as described." There are a good many ways, I see, which are not described, but indicated. There are a good many ways of shaping a filament mentioned?—Yes.

But there is no mode of carbonising described, is there?—He does not go into detail about that, but he tells you that it is to be put into a closed chamber at a high heat.

I do not think so. We will follow that out. At page 3, line 44, you will see this: "I have discovered that even a cotton thread, properly carbonised, and placed in a sealed glass bulb exhausted to one-millionth of an atmosphere offers from 100 to 500 ohms resistance to the passage of the current, and that it is absolutely stable at very high temperatures." So far with regard to cotton thread properly carbonised. Then: "If the thread be coiled as a spiral and carbonised, or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber be so coiled," then so on, and so on. But I find no mode of carbonisation shown for the cotton thread, or indeed for the thread coiled in the spiral. "If the thread be coiled as a spiral and carbonised, or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber be so coiled," and so on.

(The Court then adjourned for the day.)

Wednesday, May 12th, 1886.

Dr. JOHN HOPKINSON, recalled, and further cross-examined by Mr. Charles: Would you please turn to M. Sidot's paper again for a moment? The question I want to put to you is, whether by the means described in this last passage of Sidot's paper it is not practicable to get a carbon filament of high resistance?—I think not.

Why not?—These apparently go nothing beyond a centimetre in length, and they are filaments in a different sense from those which Edison describes, inasmuch as that they are not uniform in section, being composed of little balls in contact with each other.

Are there not incandescent lamps in existence with filaments of less than a centimetre in length?—Yes. Whether you call them filaments or not, I am not quite sure. The lamps I have in mind I should hardly speak of as having filaments.

Take, for instance, the lamps which illuminated the gardens at the Inventions Exhibition last year. Were they not incandescent lamps with a filament about a centimetre in length?—I do not think I have seen one close, but my impression is they would be more.

Mr. JUSTICE BUTT: Taking your translation of this as it stands. I am not quite satisfied it is right. If you take, say, half-a-dozen marbles, and put them down on the desk touching one another, that would be a filament according to his description of it here, if it is rightly translated as formed of little balls in juxtaposition.

Mr. CHARLES: I think the translation is correct, but I am informed that the filament in question would be perfectly uniform.

Mr. JUSTICE BUTT: How could they be perfectly uniform if they were composed in that way? I do not see how that could be.

Mr. CHARLES: I shall be able to show that the balls which touch each other are the infinitesimal molecules.

Mr. JUSTICE BUTT: That is why I said I doubted whether it was a correct expression. I daresay it is literally correct, but it does not convey to one's mind what the writer means.

Mr. CHARLES: I will now pass on to where we broke off yesterday. Go back, please, to Mr. Edison's patent, 4,576. Do you find anywhere in that patent any description of the method of carbonisation, except in reference to spirals?—No. In both cases in which he speaks of carbonisation in a closed chamber he refers to spirals.

Re-examined by Mr. ASTON: Your attention was called yesterday to a statement made by Mr. Swan in a lecture delivered at the Royal Institution in March, 1882. In that lecture your attention was called to the fact that Mr. Swan, in speaking of certain lamps of his, referred to the carbon as carbon filaments. I will read to you what Mr. Swan said at a meeting in February, 1879: "Among the many uses to which the electric light was put, he mentioned the lighting of Sir William Armstrong's picture gallery at Craigside, Rothbury. In the abstract of a report of two engineers on the cost of working for a month on a small scale the Jablochkoff candle system at Westgate-on-Sea, the relative cost of electric light and gas light was put at 4 to 1. . . . . What was required to make street lighting and shop and house lighting successful was an electric lamp in which there was no waste of carbon and no waste of machinery. Mr. Edison said he had invented such a lamp; Mr. Sawyer said he also had. If this were true, and if along with these advantages those lamps gave a satisfactory return in light for the electricity spent, then the chief problem was solved, and they would not have to wait long for a very extended development of electric lighting. But, in any event, even if it should happen that those inventors had not accomplished quite as much as we have been led to expect, the problem of a simple and economical lamp would, he did not doubt, be ultimately solved, and with its solution electricity would become a means of illuminating." Then, in December, 1879, Mr. Swan says: "At a recent meeting of the society Mr. Barnard Proctor read a short paper 'On the Smoke of an Electric Lamp.' It will, I believe, be remembered that the lamp referred to consisted of a globe of glass (about three inches in diameter) containing a rod of carbon. The rod was ·04 of an inch in diameter and 1·2 inch long. It was held in a central position in the globe by sockets of platinum attached to platinum wires, which passed through opposite sides of the globe and were hermetically sealed in it. The globe was carefully exhausted of air by a Sprengel pump. A current of electricity had been passed through the carbon rod, which raised it to a state of intense incandescence, and even bent it in such a manner as even suggested that it had perhaps been softened by the intense heat. After the lapse of about a minute, during which a light was emitted sufficiently brilliant to illuminate a room about 40 feet square, the intense heat to which the carbon had been raised communicated itself to the platinum sockets and melted them, and so caused an interruption of the electric current and extinction of the light. When the globe came to be examined it was found to be coated with a deposit having the appearance of carbon, but as it was difficult to imagine how carbon had got there it was desirable that it should be proved whether it was really carbon or not, and my friend, Mr. Barnard Proctor, took in hand to examine into the nature of the deposit. The result of that examination has already been laid before you, as I have mentioned, and you will remember that the deposit proved to be for the most part carbon. That was one point settled. Another point which remains to be settled was the question how the carbon deposit got where it was found, whether, contrary to common

belief, carbon was volatile, or whether its transport could be explained in any other manner. The object of my notice is to state that this last point has also been settled. Experiments which I, with the co-operation of my friend, Mr. Stearn, have recently made conclusively proved that the deposit, which occurs under the conditions described, is due to the mechanical transport of carbon particles, the residual air contained within the globe being the medium. We find the less air there is left in the globe the less deposit to take place; and we have succeeded in so nearly exhausting some globes that no deposit whatever takes place after a long continued ignition of the carbon rod."

Mr. JUSTICE BUTT: Does that mean that the carbon was volatile or not?

Mr. ASTON: It was either volatile, about which there may be some doubt, or else owing to the action of any residuum of air that was left; the air is in a continual state of what Mr. Crookes calls bombardment, and it may have been by the action of the atmosphere, the particles being detached from the carbon rod, carried by the air and deposited on the surface.

Mr. JUSTICE BUTT (to Witness): Would you describe that as volatile?—No. As I understand, what Mr. Swan here means to convey is that his experiments show that the transference of carbon to the walls of the reservoir is not dependent possibly on the heat, but depends also on the presence of some quantity of gas, and that therefore the gas must be regarded as in some sense conveying the carbon.

Mr. JUSTICE BUTT: I should like to know whether it meant that carbon is or is not volatile.

Mr. ASTON: I think Mr. Swan was taking the view that it was not volatile.

WITNESS: I take it he means in this case the fact was not due to any volatilisation of carbon.

Mr. ASTON: Having had your attention called to those two expressions, what do you say is the carbon which was shown in the lamp here yesterday?—He says distinctly here that in the two lamps which he had shown the carbon was a rod a 25th of an inch in diameter and about an inch and a fifth long.

Under those circumstances, would it have a certain amount of rigidity?—Undoubtedly. Its flexibility would be almost insensible.

If it were rigid, and held at the two ends, would there, under heat, be an expansion and contraction of the rod?—Yes.

What would be the result of that, do you think?—It would undoubtedly tend to bend it or else to bend the wire.

Would that contribute to the efficiency of the lamp?—No.

What would have been the result of the expansion and contraction of that rod, which would have a certain amount of rigidity?—There would be a tendency to its destruction mechanically. Whether that was the cause of the destruction, I do not know.

Have all the filaments described by Edison flexibility and resiliency?—I should expect to find it in every case to a sensible extent.

I understood you to tell my lord yesterday that those are qualities which enable a lamp to be moved about with reasonable safety?—Yes; they no doubt are valuable in that respect.

Bearing that in mind, what do you say with regard to whether the carbon used in the Swan lamp is or is not such a thing, whatever the thing may be, as what Edison calls a filament in his specification?—I do not know that a rod of carbon the 25th of an inch in diameter and 1·2 inch long would be described by anyone as a filament.

Is it such a thing as Edison in his specification describes as a filament?—Most certainly not. He there gave some idea of the dimensions, which are very different from these. Nor would it have such an electrical resistance as he indicates.

Now, your attention was called to certain extracts which set out part of a paper of M. Sidot, taken from the *Comptes Rendus*. Generally, does Sidot describe any filament such as you find described in Edison's specification?—No. The real point of Sidot's investigation is the deposition of carbon from a gas or vapour containing carbon, by heat. That is apparent from the last paragraph, in which the carbon is deposited upon the walls of the tube or receptacle in which the gas is contained.

The SOLICITOR-GENERAL: He also describes the carbonising of paper and silk?—He certainly describes the carbonisation of those bodies by the heat, but at the same time there would be a deposit of carbon upon them in an irregular way from the surrounding gas, which would make it quite impossible that in this way a useful filament should be produced.

Mr. ASTON: Does Sidot in any way produce the use of such a filament for an electric lamp?—He speaks of using, not the filaments, but crayons produced by this process, as I gather, for arc lighting.

The SOLICITOR-GENERAL: He says: "It becomes gradually incandescent over its whole surface." Does not that show that what he had in his mind was an incandescent lamp?—I think not. I think he is there referring to the conductivity of the material for heat being similar to a metal, and therefore if you heat it in one point the heat will be conducted all over.

Reading these words: "This carbon conductor becomes heated in the same manner as a metal and becomes gradually incandescent over its whole surface without breaking into a flame at any single point like ordinary carbon." Would not that point an experienced person to a material useful for a burner of an incandescent lamp?—Certainly not, because he refers there to breaking into flame at any point; the fact of referring to breaking into flame would go to show that he did not there contemplate an incandescent lamp with carbon, all of which had been made in a case containing no oxygen or else in vacuo. I am pretty clear in my own mind what that is meant to illustrate. He means there to show that this carbon is a good conductor for heat, and that consequently it would become uniformly heated, and it would be difficult to heat it at any one point.

I will not agree with you. I also ask you this, whether Sidot's filaments, made from cotton, paper and silk, are not described as elastic and conductive?—Yes.

And to that extent would they not have the same distinctive qualities as my learned friends insist on with regard to Edison's filament?—They would have the properties of being elastic and conductive undoubtedly; or he says so, at all events.

Dr. JOHN AMBROSE FLEMING, Professor of Electrical Technology in University College, and electrical adviser to the plaintiff company, was next sworn. He said he agreed substantially with the evidence given by Sir Frederick Bramwell. An electric lamp such as Edison described was new at the date of patent, 4,576; prior to that date he had never seen nor read of a filament, such as Edison described, being used. The specification would enable an ordinary skilled workman to make such a lamp as described. He could call to mind no incandescent lamps that were used practically which contained a rigid carbon pencil or rod. In a rigid rod there was an absence of that flexibility or elasticity which is essential to enable the carbon to accommodate itself to changes of temperature, and it would not, therefore, be suitable for an incandescent lamp. Opinions differed as to what the actual temperature of the carbon in an incandescent lamp was, but it was generally assumed to be something near 2,000 degrees centigrade. He had recently made some experiments with a Swan lamp, of the kind relied upon by the defendants as being an anticipation. He first of all verified, as far as possible, the dimensions of the carbon, which was not according to his view, a filament properly so-called. He next endeavoured to ascertain the electrical resistance of the lamp, expecting to find it something small, but in its then condition he found it very high and uncertain, variable. The inference he drew was that there was a variable contact at the place where the carbon rod was joined to the platinum wire, and this variability of contact, he concluded, had been produced by the expansion and contraction of the carbon rod when the lamp was used for the first time. The carbon rod, being rigid, would expand when heated, and unless it bent it would probably deform the platinum wires, or render the contact uncertain; if there were a good connection there would be a low resistance. These experiments indicated that that form of lamp would not be a form adapted for commercial use. He knew of no such lamps now in use. He also made an examination of one of the defendants' lamps, and compared it with those of the plaintiff company. The platinum terminals of the defendants' lamp were constructed in the manner described in Gimingham's specification. The wires were first of all apparently flattened out, and then bent round into two small tubular clamps, into which the carbon filaments were inserted. At the date of Mr. Gimingham's patent, September 29th, 1881, those means of effecting the junction were, so far as he could say, new.

Cross-examined by the SOLICITOR-GENERAL: I observe that you answered my learned friend Mr. Aston's question that you had never known of a filament such as Edison describes in his patent being used in a closed vessel of glass, and so forth. I presume you refer to such as Edison describes in his patent which is being sued on, No. 4,576?—Yes.

Will you point out to me in Edison's specification the passage in which you say that he describes the filament, because we are unable to find it, I tell you honestly, in the final specification?—I think it is described in the final specification, page 3, lines 44, and onwards.

He says: "I have discovered that even a cotton thread properly carbonised and placed in a sealed glass bulb, exhausted to one-millionth of an atmosphere, offers from 100 to 500 ohms resistance to the passage of the current." That is the statement of what he has discovered?—Read further onwards; the whole of that paragraph.

I will read the whole of the paragraph, but I want, as I am perfectly entitled to do, to break it up. "And that it is absolutely stable at very high temperatures; that if the thread be coiled as a spiral and carbonised, or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber be so coiled that as much as 2,000 ohms resistance may be obtained without presenting a radiating surface greater than three-sixteenths of an inch." Is that the passage to which you refer?—That is the passage.

Point out in that passage whether you see what you refer to.

Mr. MOULTON: You ought to read a little further.

The SOLICITOR-GENERAL: I will read where you like, but I am perfectly entitled to stop when I like and ask a question, subject to explanation. "That if such fibrous material be rubbed with a plastic compound composed of lampblack and tar, its resistance may be made high or low, according to the amount of lampblack placed on it. I have also discovered that carbon filaments may be made by a combination of tar and lampblack, the latter being previously ignited in a closed crucible for several hours, and afterwards moistened and kneaded until it assumes the consistency of thick putty." I ask you in which of the words of that sentence you find a carbon filament described?—In the words on page 3, line 48: "Or if any fibrous vegetable substance which will leave a carbon residue after heating in a closed chamber."

Now, I will ask you first whether there was any novelty in carbonising a fibrous vegetable substance by heating it in a closed chamber at that time?—Not a mere carbonising.

I am asking you a perfectly definite question: whether there was any novelty in carbonising a fibrous vegetable substance by heating it in a closed chamber?—No.

Now I will ask you further, because I want to understand your evidence, whether you refer to anything else as a carbon filament, such as Edison describes?—The first ten lines on page 4.

That is the lampblack?—Yes.

"I have also discovered that carbon filaments may be made by a combination of tar and lampblack, the latter being previously ignited in a closed crucible for several hours, and afterwards moistened and kneaded until it assumes the consistency of thick putty. Small pieces of this material"——. I understand that to mean the tar and lamp-black?—Yes. I understand it to mean the tar and lamp-black.

"Small pieces of this material may be rolled out in the form of wire, as small as seven one-thousandths of an inch in diameter, and over a foot in length, and the same may be coated with a non-conducting, non-carbonisable substance, and wound on a bobbin or as a spiral, and the tar carbonised in a closed chamber by subjecting it to high heat, the spiral, after carbonisation, retaining its form." That all relates to the tar and lamp-black exclusively?—I think so.

And the following sentence also relates to it?—Yes.

With the exception of the carbonisation of a fibrous vegetable substance, and the making carbon filaments with tar and lamp-black in the manner described by Edison, is there any other description of a carbon filament such as Edison describes?—I find that he speaks lower down of the carbon wire, line 29.

"When fibrous material is used the plastic lampblack and tar is employed to secure it to the platina wires before carbonising. By using the carbon wire of such high resistance, I am enabled to use fine platinum wires." That is the carbon wire which he has previously been referring to?—Yes.

And the same thing as the carbon filament? He calls it wire in that place?—Yes.

But he does not describe there, does he, any particular form of carbon wire, or carbon filament?—No, except by speaking of it as a carbon wire.

(To be continued.)

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED, *v.* WOODHOUSE AND RAWSON.

SECOND ACTION.

(*Before* Mr. JUSTICE BUTT, *sitting in Chancery.*)

THIS action, which was commenced upon the termination of that the judgment in which we published last week, was for the alleged infringement of Specification No. 4,847, of 1878, a communication to Frederick John Cheesbrough from Messrs. Sawyer and Man, of New York, describing an improved method of charging an electric lamp, the production of a better carbon for use in electric lamps, and for other electric purposes.

Counsel for the plaintiffs, as in the first case, were Sir Richard Webster, Q.C., Mr. Aston, Q.C., Mr. Moulton, Q.C., and Mr. P. Edward Dove; and for the defendants, the Solicitor-General (Sir Horace Davey, Q.C.), Mr. Charles, Q.C., Mr. Macrory, and Mr. H. G. Rawson.

The witnesses called by the plaintiffs were Sir Frederick Bramwell, Dr. Hopkinson, Mr. Imray, Prof. Dewar, and Dr. Tidy. No witnesses were called for the defence, and infringement was admitted, if the patent were held to be valid.

The Solicitor-General argued that there was anticipation of the process described and the material used by Cheesbrough, quoting papers by Sidot, St. Edmé, and Despretz in support.

Mr. JUSTICE BUTT delivered judgment on Tuesday as follows: The plaintiffs in this action are the owners of a patent, No. 4,847, dated November 28th, 1878, as amended by disclaimer of November 12th, 1884. The claim is against the defendants for the infringement of that patent. The patent is one for making the carbon conductors of electric lamps. The process by which the desired result is obtained is, to my mind, one of singular beauty and efficacy. The principal features of that process are these: a pencil of ordinary carbon is immersed in a hydro-carbon gas or liquid, a strong electric current is passed through the carbon, and in the course of its treatment the carbon is subjected to a gradually increased current of electricity. The defects in ordinary carbon for electric lighting, and the remedies applied by his process, are thus stated by the patentee in his specification: "As is well known, carbon suitable for electric lighting by the voltaic arc, is naturally produced in gas retorts, but generally the rods of carbon used in the regulator lamps so called are moulded from the powdered material. Neither the one nor the other quality of carbon is suitable for electric lighting by incandescence. In both there is a lack of homogeneity. The pencil is not sufficiently hard and dense, because in the first place the heat required to produce the proper character of carbon is as high as 7,000° Fahr., and such a temperature is not obtainable in the retort; and, in the second place, the mechanical subdivisions of the material, and the pressure necessary to produce the perfect article are practically unattainable. Carbon of the ordinary sort when heated by the electric current exhibits points and lines of unequal brilliancy. Carbons prepared by this process, when so heated glow with a uniform brilliancy throughout." The principal part of that relates to the objections to the use of the ordinary carbon for the electric light. Now comes the improvement: "It has been found that a pencil of carbon immersed in a hydro-carbon gas or liquid, and heated to an extremely high temperature by the voltaic current is not itself attacked, but decomposes the surrounding matter, the carbon of which enters and fills up its pores to an extent impossible except with matter in a very attenuated state, and deposits a perfectly homogeneous layer, generally of a bright gray colour, upon the exterior surface. As the carbon increases in size more current is required to maintain its temperature, and if the current is gradually increased in accordance with the demand for it, there is apparently no limit to the increase in mass of the homogeneous exterior deposit. Carbon pencils may be cut from this deposit, or the original pencil with its coating may be used in the lamps. In this process it will be seen that the carbon is never in contact with the liquid in which it is immersed, but surrounded by a carbonic gas of very high temperature; beeswax, balsam, and most oils, if pure, operate satisfactorily, almost any hydro-carbon, in fact, will answer." The peculiar merit of the invention consists in the well-nigh perfect adaptation of the means employed to the end aimed at, and this by the automatic action of the materials employed when subjected to intense heat generated by the passage of the electric current. As pointed out, in an ordinary piece of carbon subjected to a strong electric current, there are observed points and lines of unequal brilliancy. The most brilliant parts are those where the carbon has the smallest sectional area, the resistance of the carbon to the passage of the electric current, and therefore the heat, being in inverse proportion to the size of the cross-section of the carbon. At these points of greatest heat the deposition of the carbonaceous matter by means of the hydro-carbon gas is most active, and so equalises the carbon, which is also made more dense by the operation. That being the patent, I do not understand that there is any serious dispute that, if valid, it has been infringed by the defendants. The answer to the action is, not that they have not used the process or the material in question, but that they have a perfect right so to do, because the patent is invalid, inasmuch as the process by which the material was made was known long before the date of the patent in question. The process and the material were common property, which the public, and they as part of the public, were entitled to apply to any purpose they chose, for electric lighting by incandescence amongst other things. The question arises, therefore, was this process known before Cheesbrough's specification? That appears to me to be the principal question in the cause, though there are some other objections made by the Solicitor-General to the validity of this patent. With those objections I propose to deal in the first instance. In the first place, a reference was made by the Solicitor-General to lines 5 and 6 of the 12th page of the specification. In stating the objects of the invention the patentee there says, after having detailed some others: "To obviate these several difficulties is the object of this invention. To charge the lamp it is preferred to employ nitrogen gas, and this is produced in the lamp by an improved process in a state of great purity." It is objected that there is no direction in the course of the specification given to the public how to make that improved nitrogen gas. But on looking to the claim, or to that part of it which refers to the passage I have read, namely claim No. 3, I do not see that any claim is made for an improved nitrogen gas. The words of claim 3 are as follows: "3. The hereinbefore described method of preparing the illuminating part of an electric lamp consisting in first obtaining a solid deposit of carbon by electric action as set forth, and subsequently when the globe containing it is charged with a carbon preservative atmosphere, before the flow of such preservative atmosphere through the lamp has ceased and before the lamp is finally sealed, heating the illuminating part by means of the electric current, in order to expel impurities and occlude gases." The nitrogen gas, as I understand it, is there referred to in these words: "It is charged with a carbon preservative atmosphere." And in another part of the specification he states that anybody knows how to get or to make the material used. I point out, in the first instance, that there is no claim, strictly so-called, to the use of the improved nitrogen gas. But at page 14, line 34, these words are used: "The lamp being set up the next important thing is to charge it with the atmosphere, which will prevent consumption of the carbon, and the detailed description of the process of charging the lamp is as follows." Now, before that word "process" he had, in the first instance, the word "improved;" "improved process," it read originally, "of charging the lamp is as follows." Therefore, he struck out that word "improved." But it may be said, and I think it was said: "That is all very well; but that refers, not to the manufacture or the making of the improved nitrogen gas, but to the charging of the lamp." Well, I do not quite agree; I cannot agree that that refers only to the charging of the lamp when the gas is made, because directly afterwards I find this: "The detailed description of the process" (originally it was "improved process") "of charging the lamp, is as follows: The various methods of manufacturing nitrogen gas are well-known. Having dried and purified the gas until it stands all tests, it is passed into a dry receiver, preferably a bag of vulcanised rubber." In starting to describe the charging of the lamp, the very first thing he does is to tell you what gas to use. Therefore, I think the objection, properly considered, really amounts to a little more than a verbal criticism, and there is no substance in it. Secondly, it is said that the patent is void, because it describes various methods of making the

material, some of which methods will not answer; in other words, that it would mislead the public. The first claim is in these words: "The herein described method of preparing the illuminating part of an electric lamp, consisting of electrically heating the same, while it is surrounded by a carbon gas or liquid." Now, the "herein described method" mentioned in that claim, refers to a passage at page 15 of the specification. It is a passage which I have read once already, but to which I shall have to refer more than once in the course of my judgment. "It has been found," it says, "that the pencil of carbon immersed in a hydro-carbon gas or liquid, and heated to an extremely high temperature by the voltaic current, is not itself attacked, but decomposes the surrounding matter, the carbon of which enters and fills up the pores," and so on. And then further on, line 44, he says: "In this process it will be seen that the carbon is never in contact with the liquid in which it is immersed, but surrounded by a carbonic gas of very high temperature; beeswax, balsam," and so on; and then he says: "almost any hydro-carbon, in fact, will answer." We have, therefore, three terms used: he speaks of a hydro-carbon gas, he speaks of a carbon gas and of a carbonic gas; and from the evidence I do not think he meant exactly what he said in using any one of those expressions. Dr. Tidy, I think, said, in answer to the Solicitor-General, that the term hydro-carbon gas, as used by him here, is clearly an erroneous one, strictly speaking, in a chemical sense; because strictly speaking, as I understood the matter, hydro-carbon gas consists of carbon and hydrogen alone, without any other element mingled with it. That is clearly not what the patentee was referring to. I do not know whether very much turns upon that. But when you come to the other two things mentioned, carbonic gas or carbon gas, probably the same thing is indicated. It is said: "But that will include some gases which, if applied, would not produce the result at all. It would not, says the Solicitor-General—and he is warranted in the assertion by the answers he got from Dr. Tidy, and I think one or two of the other scientific witnesses—it would not produce the effect; it would include both carbonic acid and carbonic oxide, and if you used either one of those two ingredients you would fail to get the deposit which you are seeking to get on to your carbon pencil, and your whole operation would fail. Well, if the specification is really to be read as a direction to the public to use either one of those gases, then I should agree that the process, as described, is a futile process, which would be misleading to the public, and that the objection had assumed very serious proportions indeed. But then I do not think he really meant that, and I need not give my own reasons for saying so, because I get them better from the evidence of one or two of the witnesses. In the first place I will refer to what Dr. Hopkinson, in cross-examination, has said: "In the sense I understand the patentee to use the words carbonic gas, which would include carbonic oxide and carbonic acid, carbonic oxide and carbonic acid would not effect the purposes of making the deposit." Then I find Dr. Tidy is examined upon the point, and he is asked with reference to the expression hydro-carbon gas or liquid: "Is that a correct expression?" He says: "From what follows objection may be taken to it undoubtedly, from the strictly chemical stand point, because in strict chemical language we understand by hydro-carbon a body that contains only carbon and hydrogen and nothing else. But I think by the term hydro-carbon in this specification is clearly meant a body that contains carbon and hydrogen. The word is not used to my mind in the chemical sense in this specification, but as a body that contains carbon and hydrogen, though not carbon and hydrogen exclusively. I will make my meaning clear by saying, in all chemical manuals and phraseology we do not speak of oil and beeswax as hydro-carbon, although they do contain hydrogen and carbon." I may here say that beeswax is stated as one of the things that would do for the purpose. "We speak, for instance, of marsh gas and benzole, which has been mentioned before, as hydro-carbon, because they contain carbon and hydrogen only. Therefore, in strictly chemical language, I am prepared to admit that that would be an inaccurate phrase." Then a little further on he goes to the other point. Mr. Aston says: "I should like to ask whether, reading this specification on the principle of fairly understanding it—that is what I mean by a willing mind—would any person be led to try carbonic oxide or carbonic acid?—(A.) No, I should not think so. (Q.) Why not?—(A.) I cannot imagine that anybody would ever dream of trying it. (Q.) Just tell my lord why. Can you not give some popular reason?—(A.) First of all, you could not get any carbon deposit from them by the process that is suggested. (Q.) Would anybody know that?—(A.) Any text book would have told them, I would have thought." Although I am speaking from recollection, I thought I heard him say: "Any sixpenny text book." Perhaps it did not reach the shorthand writer, but I am confident I heard it. When he comes to be cross-examined by the Solicitor-General, he says: "It is not an expression I should have adopted myself. (Q.) Do you not understand by the expression carbon gas, a gas of which carbon is one of the constituent elements? That is the way I should prefer to put it.—(A.) I do. (Q.) Would not carbonic acid be a carbon gas in that sense?—(A.) Yes; in that sense, certainly. (Q.) Would not carbonic oxide in that sense be a carbon gas?—(A.) In that sense, certainly. (Q.) They would come under the description of a carbon gas in that sense?—(A.) In that sense, certainly. (Q.) You tell my lord, from your great knowledge, and of the distinction we all know you are, you are aware that carbonic oxide and carbonic acid would not have the result that Cheesbrough contemplated; the gas being decomposed and the carbon deposited?—(A.) No. (Q.) You know it?—(A.) Certainly. It would not have that result. (Q.) What reason have you for saying that Cheesbrough knew it?—(A.) I can only refer you to what is in the body of the specification." Then there is further discussion upon that, and there the matter, so far, ends. Now, it certainly does appear to me, having regard to the expression used, having regard to Dr. Tidy's statement on oath, which is absolutely uncontradicted, that no man of ordinary knowledge, in his senses, would think of applying carbonic oxide or carbonic acid to this operation—it seems to me it would be an extremely hard and unjust interpretation of this specification to hold that the patentee invited the public to use carbonic oxide or carbonic acid, and so render his patent void. I now come to what I regard as the real question before us. Was this process known before Mr. Cheesbrough's specification? A great number of applications have been referred to by the defendants in support of their contention that neither process nor material was new. I think the only publications requiring serious consideration in this relation are those of M. Sidot, which was made in the year 1870, and M. Despretz, at a still earlier period, in 1849. I will take M. Sidot's paper first. No doubt, in the course of some experiments he was making—not with the view of electric lighting, as I understood it—M. Sidot produced a material resembling that which results from the process patented. But it appears to me impossible, on the evidence, to say that he either described a process that would make the material, or that he did make the material produced by Mr. Cheesbrough's process. The evidence satisfies me that the desired result cannot be obtained by the application of external or furnace heat as contradistinguished from heat produced by electric action as used by Mr. Cheesbrough. Sir Frederick Bramwell, in his evidence, deals with that matter, and I will refer shortly to what he says upon the subject. He points out this in substance, that uniformity of heat produces uniformity of deposit per unit of the area; and that is just what you do not want in your process for producing the carbon conductor described by Mr. Cheesbrough. Then there is a passage of at least equal importance in Prof. Dewar's evidence, to which I will now advert. Prof. Dewar is also asked about Sidot's experiment, and he says: "Sidot's experiment shows that the main deposit at a high heat is on the walls of the tube and not on the wood. (Q.) Very well. Some would deposit on the wood?—(A.) I have no doubt some would. (Q.) Assuming that some is deposited on the wood, are you able to point out any difference in the carbon which has the extra deposit put upon it by Sidot and the carbon which has the extra deposit put upon it by Cheesbrough?—(A.) I do not think they have anything in common. (Q.) Tell my lord why, if you please.—(A.) I have already said that carbon produced by electric action at the high temperature which is pointed out by Cheesbrough cannot be produced by any furnace operations." It must be remembered that Sidot's operation was purely a furnace operation and nothing else, heat produced by fire from the outside. "I have said that all carbon necessarily contains hydrogen, more or less along with other impurities." I asked him: "You say it is not the same material?—(A.) I say it is carbon, more or less, but it is not the same material. I say it is not in the same physical condition." That evidence is wholly uncontradicted.

The SOLICITOR-GENERAL said there was cross-examination upon that point, and the effect of Prof. Dewar's answers was that it was a question of degree.

Mr. JUSTICE BUTT: I thought that was Despretz.

The SOLICITOR-GENERAL: No, my lord; it was Sidot.

Mr. JUSTICE BUTT: I have a distinct recollection of what he said, but I was under the impression it was in regard to Despretz and not Sidot. However that may be, I think degree has everything to do with the matter here, because in this electric conductor the degree of improvement in making, the degree in which you fill up the pores, the degree to which you give it density, is all important, and if Sidot's will not do it, I do not think Sidot's paper can be called an anticipation. I now come to Despretz's paper, published in 1849. I have no doubt Despretz produced a material in substance very like, if not identical with that used for the carbon conductor patented by Mr. Cheesbrough, and he got the heat he supplied by means of an electric current. But there is one most important object obtained by the process patented by Mr. Cheesbrough, which I think the defendants have failed to show that Despretz's process would yield. The principal object of this patent is to ensure the filling up, in the course of the treatment, of the pores of the carbon, the porosity of ordinary carbon being a serious objection to its use for incandescent lighting. Now one part of the process described in the specification is a gradual increase of the electric currents. This was certainly no part of Despretz's process. Is it an important matter? All or nearly all the witnesses referred to it as a matter of significance. Prof. Dewar says that it is essential to cure the porosity of the carbon. My note of Prof. Dewar's evidence upon this point is as follows: "He (that is, speaking of the patentee) also points out the advantage of a gradual increase of the intensity of the current. For Cheesbrough's purposes you must have an intense electric current increased from a less intense one. I find no direction of all this in the anticipation; that is in Despretz. Despretz used an enormous current, but he put out the whole at once; it was not graduated." Then he goes on to Sidot: "I have experimented with Sidot's process;" and then he refers to those experiments. "I say the carbon produced by Sidot is not the same as Cheesbrough's, not in the same physical condition. I say you cannot get Cheesbrough's carbon from any process carried out by external heating." Then, in coming to Despretz, he says: "There is nothing in Despretz's paper which would suggest its application to the purpose of getting a good carbon conductor

for an incandescent lamp. I have not the slightest doubt but that the porosity of the carbon was not cured by Despretz's process, because he did not apply the graduated current."

The SOLICITOR-GENERAL said he did not want to interrupt, but his lordship of course remembered that in cross-examinination Prof. Dewar withdrew what he had said in chief, that the graduated current was essential to Cheesbrough's process.

Mr. JUSTICE BUTT: I do not think so. I did not understand him so.

The SOLICITOR-GENERAL: I asked the question: "As I understand, you tell my learned friend you considered the graduated character of the current was essential to the process. Prof. Dewar: Well, I think I may nearly go that length. But you did go that length.—But I did not mean essential in that sense. I will say candidly I did not say essential in the sense that it could not be carried out without it. It would be highly advantageous. I might go as far as that." Then some discussion as to why he used the word "essential," and he says: "I say candidly I did not intend to convey that it was not possible to carry out the process without it. (Q.) But highly advantageous?—(A.) Yes; so highly advantageous as to be almost essential." Further on, he says: "I did not mean to go that length;" that is to say, "as to be almost necessary." I ask him to point out some passage in which Cheesbrough says the graduated current is highly advantageous, and he admits that he cannot.

Mr. JUSTICE BUTT: I have read this evidence, and I am trying to understand it as far as I am able. I read all those passages, and I cannot conceal from myself that in the evidence of many of these gentlemen, in one part and the other, there are discrepancies in the context. But the conclusion to which I have come upon the whole is, that Prof. Dewar, taking the whole of his evidence, examination, and cross-examination, intended to abide by this, that you could not cure the porosity without the gradual increase in the current. If I am wrong upon that point, the defendants will have an opportunity of reviewing the whole of the evidence and setting me right hereafter. At the moment I did not recollect this passage, but I had marked it, and the conclusion I have formed on the whole of the evidence is, that I certainly do not feel that I could come to the conclusion that M. Despretz, in the paper in question, has described a process which would enable a a competent workman to arrive at the result Mr. Cheesbrough has obtained. Had I thought otherwise I should have taken time to consider whether the admitted publication in England—for it is admitted—of M. Despretz's paper would have been what is called an anticipation of Mr. Cheesbrough's invention. M. Despretz's paper is entitled "Volatilisation of Carbon;" it relates to experiments on the volatilisation of carbon, a process the very reverse, as I understand it, of that which an electrician would desire to bring about for the purposes of electric lighting. The material alleged to be identical with that of Mr. Cheesbrough's improved carbon conductor was not a material which M. Despretz was seeking to obtain; it came upon him as a surprise, and as a disturbing element in the course of his experiments, interfered with the achievement of the object he had in view, and its presence does not, certainly, seem to have been regarded by him with any degree of satisfaction. Moreover, his experiment never seems to have been repeated from the year 1849 down to the time of Mr. Cheesbrough's specification, nor during that period do we find the material in question ever applied to any useful or practical purpose. I would here refer to one passage in Dr. Hopkinson's evidence. Despretz's publication, he says, has no reference to incandescent lighting, and would not be a publication to which an inventor of an incandescent lamp would turn; when he saw the title of that paper it would rather deter than invite him to look into it. I am, therefore, of opinion that the invention which Mr. Cheesbrough patented had not been anticipated by any prior publication of this process, that the patent sued on is valid, and, as its user by the defendant is admitted, there is infringement, for which the plaintiffs are entitled to relief.

Mr. ASTON made the usual application for an injunction in terms, an account of the profits, the delivery up of the infringing articles, subject to any arrangement which might be made between the solicitors of the parties, and for costs on the higher scale.

His LORDSHIP acceded.

THE STRANGE HISTORY OF A DYNAMO

As told by itself to

A. DYNAMICABLE.

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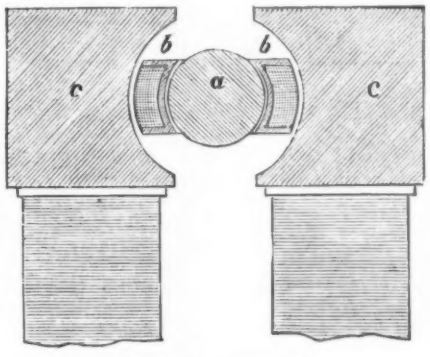
(*Continued from page* 469.)

THERE is still living in America a well-known scientist, Professor Rowland, who has also done much in a quiet sort of way in experimenting in the direction of developing the dynamo. It appears, however, that his researches were not made public, and the only record thereof exists in a note book which a Mr. Arthur S. Hathaway, more than a year ago, found in Prof. H. A. Rowland's library at Johns Hopkins University. This contains some very interesting information in regard to the dynamo-electric armature made by Prof. Rowland in 1868–9, and quietly exhibited by him at the Electrical Exhibition in Philadelphia in 1884.

Mr. Hathaway found it in a book "used while a student in the Newark Polytechnic Institute, 1868." Under date of August, 1868, is the following:—

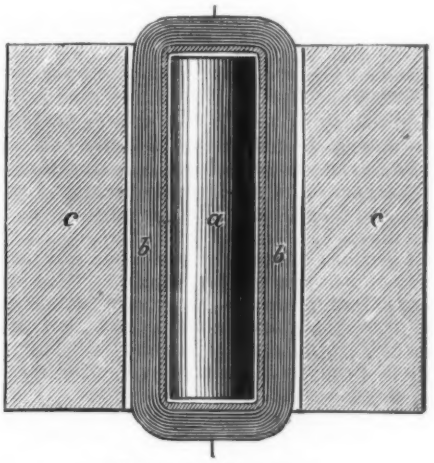
"Magneto-Electric Machines.

"In all forms of these machines yet made, a revolvable armature of iron is used. Now, it is well known that a large portion of the power used to drive these machines is absorbed in producing heat and currents of electricity in these armatures; therefore, I propose either to form them with wire, or dispense with them altogether. The figures show an arrangement for effecting the latter.



ROWLAND'S ARMATURE.

"The armature, *a*, is held stationary, while the coil, *b*, *b*, revolves around it, thus cutting lines of magnetic



ROWLAND'S ARMATURE.

force. By this arrangement, all the power will be used to produce a current in the coil, while in the ordinary form the armature has to be magnetised and demagnetised rapidly, thus absorbing power. This arises from the resistance of iron to becoming a magnet, and is well illustrated by various experiments on suspending an iron disc between the poles of a magnet; the disc has one edge weighted, and the resistance is ascertained by the time the disc takes to decrease its arc of vibration a certain quantity.

"Let the figure (fig. 3) represent a cylinder of iron between the poles of a magnet. When it is not revolving, N and S will be the induced poles; but now let it turn in the direction of the arrow, and now the induced poles, instead of being at N and S, will be carried to N′ and S′, on account of the time taken for iron to become magnetised and demagnetised. This position

of the poles will oppose a resistance to the motion, which will become greater as the velocity is accelerated. Besides this resistance of the cylinder as a magnetic metal, there is another due to the iron as a conductor. When the cylinder is revolved, currents of electricity flow as seen in the figure (fig. 4).

FIG. 3.

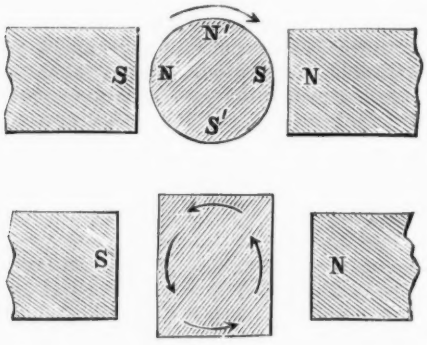


FIG. 4.

"These tend to cause the conductor to revolve around the poles in an opposite direction to that of rotation, and thus oppose a resistance. These two resistances (which form by far the greater part) are both got rid of by using the apparatus as described above."

The book from which this quotation is taken has on its title-page :—

NOTE BOOK.
FOR ADVANCEMENT IN KNOWLEDGE, &C.
No. II.
UNREVISED EDITION.
Try, Try Again.

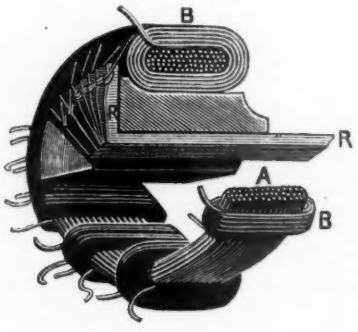
"Some, I think at this date are good, others moderate, and some bad. But I have put all into the volume because of the utility they have been to me—and none more than the bad—in pointing out to me for future, or rather, after time, the faults it became me to watch and avoid."—*Faraday.*

Mr. Hathaway says: "In the winter of 1868–9 the armature above-described was constructed with six coils. There are two windings, one for the magnet, and the other for the external circuit. Every coil makes a circuit by itself; there is only one coil in circuit at a time. This has one advantage, viz., by putting different brushes on the armature one can take off as many currents as one pleases, from the same armature. In the actual armature, the inner core (*a*) has freedom of motion, so that it may move or not as it wants to; but the coils, *b*, *b*, revolve around it. This is what Siemens first did, until he made use of discs, and so got over the difficulty."

I bring this hitherto unknown circumstance before you as a matter of historic interest; probably if the whole truth ever became known many men have obtained like results or others equally valuable, but which have never gone beyond the note-book. You can therefore set what value you please upon these recently unearthed researches of Prof. Rowland; for my part I do not see how they can be held to anticipate anything which I am now about to lay before you unless still further evidence be forthcoming.

I now pass on to a very important stage in my career; perhaps the most important of all, when viewed from a commercial standpoint, and in these days of progress everything is looked upon either favourably or not from this ground solely. Still I should be the last to grumble. Hitherto the march of science, or intellect if you prefer it, had brought me nearer and nearer to perfection electrically; but to a Frenchman, M. Gramme, is due the credit of making my worth generally known, and of sending me forth in a shape with which mechanically or electrically little fault could be found. In fact it is not too much to say that M. Gramme was the first to produce a *practical* generator of electricity yielding absolutely *continuous* currents.

Theoretically speaking, and as you can perceive for yourself from this sketch, there is not very much difference between the Gramme and Pacinotti ring armatures. Some might go so far as to say it is a distinction without a difference. This, however, would be fallacious. The latter, you remember, had teeth or projections upon its periphery or outer face, and in the spaces between were wound the coils of wire which passed through the magnetic field. The Gramme ring, for which the inventor took out a patent in the year 1870, is thus constructed :



THE GRAMME RING.

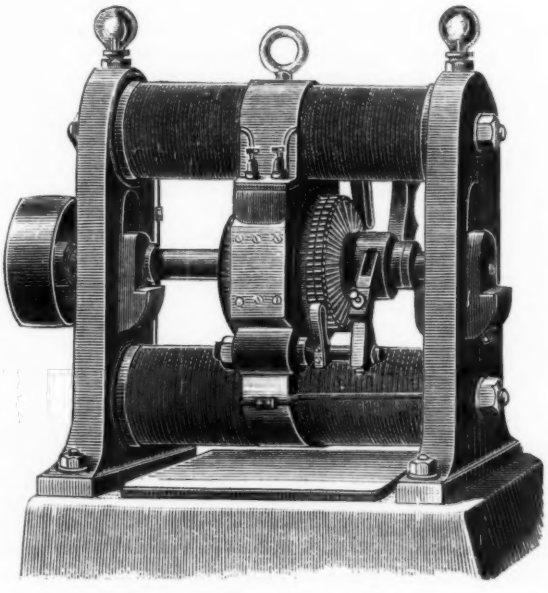
The iron portion, or core, instead of being *solid*, as in Pacinotti's machine, is formed of a continuous length of *iron wire*, A, so coiled as to form a ring of nearly an inch in thickness.

This use of thin iron wire in the place of solid metal is a distinct improvement; magnetisation and reversals of magnetism are thereby more readily accomplished, in addition to which there are other minor advantages which I need not mention here as it would involve entering too much into scientific details which I wish to avoid. The ring is perfectly smooth on both faces, and upon it are wrapped, side by side and close together, the coils of insulated copper wire, B. The ends of these are attached, in the manner already described to you when we discussed Pacinotti's invention, to the metal collecting strips, R, upon which press the brushes for taking off the current. Without further ado, therefore, we may say that the Gramme machine operates after the manner of Pacinotti's, only that in the former the self exciting principle first described by Mr. S. A. Varley is taken advantage of. Many modifications have taken place in the anatomical form of this machine, one of the latest patterns being after the fashion of this cut. A Gramme machine, of a form now obsolete, was brought to London 12 years ago, and used for several months to produce an electric light which was shown on the clock tower of your Houses of Parliament. You remember the circumstance? I expected as much. Experiments, of which I will enumerate two or three only, were made with this machine, which developed a power hitherto undreamt of. Platinum and copper wires of 15 to 30 feet in length were rendered incandescent, and a round file ½-an-inch in diameter and 4 inches long was fused in five minutes. In fact, my progenitor made it hot for them.

These old machines had no less than three armatures or rings, the current from one being employed solely to excite the field-magnets; that from the remaining two being used for external work, as, for instance, the production of an intense electric light. *En passant* I should not forget to mention that Gramme's invention was introduced into this country by the late Richard Werdermann, a devotee of electrical science, and a victim to the hardships and disappointments which so often accompany the work of a man who is in advance of the time in which he exists. M. Gramme has lived to reap the reward of his labours in a manner which does not often fall to the lot of the

poor inventor, but he richly deserves all the honours for which he has worked so well.

He found a principle awaiting practical development, and, what Alexander Graham Bell accomplished in telephony, so did Gramme in dynamo machine construction. Opinions may differ as to the just meed of praise to be awarded to the discoverer of a new principle, and to the man who practically develops that principle; the scientist would lean towards the former, the man of business would bless the latter. As a matter of fact, both are equally deserving: without the principle the practical man has nothing on which to build, without the practician the principle might for ever lay dormant. No one, then, should begrudge the success which has attended the efforts of M. Gramme, lasting as they have done over a period of nearly 20 years.



A MODERN FORM OF GRAMME MACHINE.

You may, perhaps, have wondered why I have not alluded to any improvements which might have been effected in my *alternating* current brethren since the invention of Holmes? I have purposely avoided so doing for the time being, for these are but of secondary importance at present. That they have a great future is almost certain, and I shall return to them anon. But to resume.

Next in importance to the Gramme machine, and, indeed, almost contemporary therewith, stands that of Siemens.

It may not, however, be generally known that this dynamo, which has been quite as great a success as that of Gramme, was invented by von Hefner-Alteneck. This gentleman was then chief constructor to the firm of Siemens and Halske, in Berlin. I will now ask you to follow me through a short description of the development which this apparatus has undergone.

(*To be continued.*)

REVIEWS.

Patents, Designs, and Trade Marks: British and Foreign. An outline of Laws and Procedure relative to Patents, Designs, and Trade Marks. By ABEL and IMRAY. London: 28, Southampton Buildings, Chancery Lane, W.C.

The title of this book is almost sufficient to indicate the contents. The authors of the work, who are well known as patent agents and consulting engineers, have done good service by their publication, though there are many omissions in it which greatly mar its utility. An important portion of the information which most inventors are most desirous of knowing, viz., the cost of patents, is wholly left out. We also notice that no reference is made to the fact that the forms of application can be obtained through any Post Office; indeed, the general impresssion that the book gives, is that a patent can, and should, only be taken out through an agent, to whom, of course, a fee has to be paid.

Cancer and Simple Tumours Dispersed by Electricity. By G. EDGETON, M.D. London: Henry Renshaw, 356, Strand, W.C.

This is a small book of 16 pages. The information given appears to afford one more proof that electricity, when employed in a reasonable manner, proves to be of the utmost value to suffering humanity.

Note Book and Price List with useful Formulæ. R. E. CROMPTON & CO., Mansion House Buildings, London, E.C.

We think it would have been advisable if the compilers of this book had indicated by the title what the work was a price list of. For the benefit of our readers we may mention that it refers to "Crompton Dynamo Machines," "Projectors," "Arc Lamps," "Incandescent Lamp Fittings," "Incandescent Lamps," and "Current and Potential Indicators." The formulæ, &c., occupy 13 pages, and are chiefly tables of sizes of electric light leads, showing also the loss of potential over the same. The few formulæ that are given are very judiciously selected. The attractiveness of the book is increased by the fact that it is bound in Russian leather!

NOTES.

Domestic Electric Lighting.—Another electric light installation has been successfully completed at The Hall, New Bushey, by Mr. Henry Rogers, engineer, of Watford. The place is a large "hydropathic establishment," a sort of big private hotel, and the installation consists of 108 incandescent lamps, there being 86 20-C.P. and 22 10-C.P. Swan-Edison, 96 volts and 6 ampères. The dynamo is a compound-wound "Manchester" machine, of Mather and Platt's, driven by countershafting off an ordinary 8 H.P. horizontal Bradford's engine, working up to 18 H.P., which was already in position at the Hall, and is used during the day for driving laundry machinery. The dynamo and lamps were tested and supplied by Woodhouse and Rawson. The engine runs at 120 revolutions per minute, producing 1,100 on the dynamo; and though the dynamo strap (owing to architectural constraint) had to be placed in the unfavourable position of perpendicularity over the pulley, the engine (the governors of which were changed by Mr. Rogers for Parson's high-speed governor) maintains the light perfectly steadily. The mains and branch mains have been laid of a gauge to allow of an extension of the number of lights to 150, if desired. The place is eminently suited for the electric light, as the interior of the house (which was built by Mr. Marjoribanks, the well-known banker, but sold owing to financial difficulties) is richly fitted with carved staircases and panels, embossed ceilings, &c., on which the soft and brilliant beams of the incandescent lamps fall with beautiful effect. The gas fittings already in position are used as supports, silk wires being taken down the chandeliers, &c., and the lamps, which have opal shades, are attached to the brasswork by Woodhouse and Rawson holders below the gas burners, so as not to interfere with the lighting of the gas, when desired. The main corridor and hall are lit by 12 pendant lamps enclosed in "dioptric" shades like large inverted acorns, and hanging from the ceiling by silk cords.

Temporary Electric Lighting.—An exhibition has just closed at the Town Hall of a neighbouring town, Berkhampstead, which was also successfully lit by Mr. Rogers for ten days with 33 incandescent lamps of 10 C.P., supplied by accumulators (E.P.S.) charged by a small dynamo driven by an 8 H.P. portable engine used for a threshing machine, which was lent for the occasion by a neighbouring farmer. The great hall and refreshment room were lit by the electric light, while another large hall in the building, devoted to agricultural and trade exhibits, the reading room and staircase, were supplied with gas fittings specially put up for the occasion by Messrs. Sugg, the well-known gas engineers, of Westminster. An opportunity was thus offered for a comparison of the lights, and the incandescent lamp held its own well, as, though Suggs did their part in their usual masterly style and produced a blaze of light, the soft clear ray of the electric lamp produced in the large hall a perfect illumination, without the unpleasant glare on the eyes which is usually entailed by very brilliant gas. The large hall was lined with a loan collection of handsome pictures contributed by the neighbouring gentry, and the superior effect of the electric light in showing up the colours of these was generally remarked. One or two details as to time, cost, &c., may be interesting to those who have to undertake similar installations. The consumption of coal for the ten days was a little over two tons. The engine and dynamo and accumulators were located in a neighbouring yard, the mains being carried over the housetops to the Town Hall. The installation was put up by one skilled hand and a boy in three days, including bedding of engine and dynamo, &c., and taken down, packed, and removed in one day. The light was kept on for three hours each night, taking 40—42 ampères and 42 volts. The engine driver was in attendance about seven hours each day, and, after the first day or two, no electrician was present, the engine driver being instructed as to the time to run, and the switching on and off of the dynamo, and the housekeeper shutting off the lights at the required time by another switch in the building. Though unacquainted with any electrical work, the engine driver performed these duties with every satisfaction, the moral of which is that in installations of this sort, at all events where accumulators are used, and a reasonably intelligent engineman is present, it is not necessary for a professional electrician to be detained to watch the affair after the first night.

Domestic Electric Lighting in Ireland.—Mr. Arthur S. Crawford, of Crawfordsburn, has obtained the credit of being the first to introduce the electric light into a private house in the North of Ireland. There are 100 incandescent lamps, of 20 candle-power each, distributed over a very large district, the motive power being derived from the water mill at the head of Crawfordsburn Glen, where the dynamo is placed. From the mill branch off the various cables, two passing to the workmen's cottages, about 40 yards off, as Mr. Crawford gives his labourers the advantage of this clean, brilliant, and healthy means of illumination. Two more cables pass through the west gable of the mill, and running through the bridge are carried into a little meeting-house, which is situated about 200 yards off. The third set of cables are the main ones, going direct to the house. They pass through the glen for a distance of about 300 yards, and then emerge into the open fields, where they are supported on large poles, varying from 20 to 30 feet in height. The distance between the house and mill is about three-quarters of a mile, and it is estimated that the wires and cables laid average between five and six miles in length. The entire dwelling-house is fitted most tastefully with ornamental brackets, electroliers, and pendants of polished brass surmounted by globes and shades of various artistic shapes and colours. The installation has been carried out by Mr. C. MacCarthy, of Belfast, and we understand that he has secured the large contract for illuminating the entire town of Dundald with electric light in the place of the oil lamps now in use in the streets. The political situation evidently does not seriously affect Mr. MacCarthy's business.

The Central Station Installation at Paddington.—The Paddington Electric Lighting Works were on Monday visited by some of the chief officers of the Board of Trade. The party, consisting of Major Armstrong, Mr. Meysey-Thompson, and Sir Thomas Blomefield, were received by Mr. W. Shuter, manager of the Telegraph Construction and Maintenance Company, and by Mr. J. E. H. Gordon, manager of the electric light department, and were conducted through the works and the district lighted.

Gas and Water, discussing this subject, says that the powerful lamps at the ends of the hotel at Paddington blind passengers in the street with intense violet rays; that inside the station the majority of the lights are muffled by ground glass globes, until the vaunted 3,500 C.P. is reduced to something less than 500; that floods of light are scattered about lavishly in mid and upper air whilst the platform is no more brilliantly lighted than if a series of modern regenerative lamps had been employed; and that some parts of the station are in comparative darkness, the lamp whose duty it is to illuminate the clock refusing to do so with any degree of certainty. These criticisms we believe to be fairly accurate, and, seeing that the matters of which complaint is made are for the most part remediable, it is to be hoped in the interests of the company and of electric lighting generally, that Mr. Gordon will profit by our contemporary's pointed remarks. *Gas and Water*, in fairness, admits that the lights burn with remarkable steadiness, but thinks they cannot be depended upon, as one night not long ago, the gas had to be turned on upon the arrival of a mail train.

Electric Lighting in Milan.—The Milan Electric Light Company has declared a 4 per cent. dividend on a capital of £120,000, and it anticipates making 6 for the next year. This is due greatly, the report says, to the facilities for distributing light at a distance provided by the Zipernowski-Déri system. The company kept up, at 1st January, 1885, 5,300 incandescent lamps; and at 1st January, 1886, 7,177 incandescents and 66 arcs; while at the end of March, 1886, these numbers had been increased by 846 incandescents and 13 arcs.

The Electric Light Progresses in Brooklyn.—Preparations are being made to erect 143 new electric lights, to displace 860 gas lamps, in some of the thoroughfares of the eastern and western districts of Brooklyn.

Telephonic Communication v. Signalling.—In connection with the scheme for facilitating communication with the ships at Spithead by means of the telephone (already referred to in our columns), the Admiralty proposes to erect a semaphore at Fort Gilkicker, which will be in telephonic communication with Admiralty House in Portsmouth Dockyard. The Port Admiral has accordingly directed that Her Majesty's vessels arriving at Spithead are to anchor as near Gilkicker as possible.

Electric Communication between Lightships and the Shore.—An influential meeting was held at Ramsgate last Saturday to promote electric communication between lightships and the mainland. Colonel King-Harman, M.P., was among the speakers, and promised to do all in his power to get the Government to take active steps in the matter. The following resolution was voted:—"That this meeting, being of opinion that it is desirable to promote the movement for establishing electric communication between lightships and shore, a deputation wait on the Board of Trade to impress on them the importance of the subject." The appointing of the deputation was left to the Town Council.

The Telephone at Whitehaven.—Nearly twelve months have passed since the Whitehaven and Work-

ington Exchanges were opened for business. Beginning with 19 subscribers on the list, the number has now increased to 56, an increase of 37. The total number of messages which have passed through the Exchanges during this time reach the total of 43,757. Mr. Douglas Lodder is the district manager.

The Cable Conference.—The delegates to the Cable Conference, last Friday, signed a protocol submitting to their respective Governments the conclusions arrived at during their recent session. It is recognised that the terms of the English Act of Parliament are not at variance with the convention of 1884 as regards penal provisions. With respect, however, to civil liability for injuries to cables of other companies in repairing operations, it is agreed to recommend to the Governments a declaration which virtually adopts the principle of the English Act, without accepting the limitation to different liabilities, according as the cable lies within or beyond a depth of 100 fathoms. This solution of existing difficulties was agreed to unanimously. It is proposed that the plenipotentiaries of the Powers shall meet on December 1st next, to record what has been done in each country to carry out the legislative measures necessary in order to bring the convention of 1884 into operation on January 1st next. A fresh Act of Parliament will be required in England.

Fouling an Ocean Cable.—The schooner, *Ethel*, Capt. Merchant, arrived at Gloucester, U.S.A., on April 26th. She reported that while on the Banks, April 3rd and 4th, in longitude 65° 12″, latitude 42° 33″, she fouled the old French cable. It was two days before the schooner could be cleared away from the cable, and then the anchor had to be cut away, losing it and about 60 fathoms of cable.

Telegraph Stores Wanted.—Tenders are invited for the following articles during the six months ending 31st December, delivered carriage paid at the company's telegraph stores at York, for the North Eastern Railway Company, viz.: telegraph apparatus, and telegraph wire and line stores. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York, and tenders must be sent to the Secretary at York by noon on June 8th.

Photographic Literature.—Photography has latterly been making creditable advance as an art, and its literature is become considerable. A new candidate for public favour in connection with this pleasing occupation is *The Camera*, "a monthly magazine for those who practice photography," which is likely, if its present standard of excellence is maintained, to receive extended support. Its editor is Mr. T. C. Hepworth, and Mr. Richard A. Proctor is one of its contributors.

The Monarch of the Ocean.—Mr. J. S. Moore, an American writer on political economy, has written to a New York paper upon the "cable rate war," and the *Financial News* of the 22nd inst. reproduced his letter. The writer compares Mr. Pender to Sir Joseph Porter, of H.M.S. *Pinafore* fame, and ridicules the idea that the Commercial Cable Company has been "throwing money into the sea."

A Successful Inventor.—Mr. Charles F. Brush, the distinguished inventor and electrician, has, according to the report of American contemporaries, just completed for his own occupation the finest mansion that Cleveland, a city of superb homes, can boast. It is said to be somewhat smaller, as a whole, than other well-known Cleveland houses, but to have the largest room to be found in any private dwelling in the city, and to be beyond compare in the style and richness of its decorations.

Husband's Telephones.—The article to which a correspondent, who writes about "long distance telephony," refers, may be found in the REVIEW for February 10th, 1883.

Electric Locomotion in the States.—Some months ago a very successful experiment was made by Mr. A. H. Bauer, of the Electric Storage Company, of Baltimore, on one of the Daft motor cars, for the purpose of demonstrating the practicability of secondary batteries for street car propulsion. Since then, states the *Electrical World*, Mr. Bauer has devised a novel system that can be applied to existing cars at a very small expense. An experimental car equipped with the system has been running for the past two months on an eighth of a mile track. The car used is 20 feet in length and weighs 5,400 pounds. Two beams extend from one axle to the other, and these beams carry a motor, the armature shaft being extended and having pinions on each end which mesh into counter gears; the counter shaft carries a pinion, which in turn meshes into a gear on the car axle. The motor is wound in three sections in multiple arc, and is connected with a double switch located on the platform for throwing one, two, or three of the sections in circuit with the battery as desired. To accommodate the batteries, which are placed under the seats and are entirely out of sight, the body of the car is raised three inches, so as to bring the wheels below the floor. The batteries are set on trays upon rollers, and when changes are necessary they are run out on to platforms through doors in the sides of the car, and freshly charged ones run in. The sixty cells of the battery have the same weight as the car, and the total weight of the motor, car, battery, and gearing is 5½ tons, considerably over what would be met with in actual practice. The track is one-eighth of a mile in length, beginning at the foot of a gradient of 1 in 20, 200 feet in length, on a curve of 45 feet radius. On this track the car runs continuously for six hours at a speed of six miles per hour. Calculations have been held to show that the cost of running a line of street-cars equipped with the Bauer system, should not exceed $2·21 per car per day; the average cost of horse propulsion is $4 per car per day.

The Cost of Electrical Power.—Mr. Peukert, whose excellent articles have on several occasions been translated for our columns, shows very clearly the advantages of dynamos over galvanic- or thermo-piles as a source of electrical energy. Many points of great interest may be found in his paper, and it strikes us very forcibly that the inventors of primary batteries, who claim to produce electricity for less than nothing, might peruse it with advantage to themselves.

Carbonising Lamp Filaments.—In our continuation of the evidence given in the recent incandescent lamp patent infringement case, the facts brought forth respecting Sidot's experiments are most interesting.

West London College of Electrical Engineering.—On Wednesday, May 19th, Dr. Alexander Muirhead, the great authority on ocean telegraphy, inspected the West London College of Electrical Engineering and Submarine Telegraphy, and carefully examined the artificial cable and the submarine apparatus lately introduced at that establishment. Signals were produced on the Thomson recorder similar to those received on cables varying from 900 to 2,000 knots in length. The distinguished scientist expressed his entire satisfaction, and declared that pupils who were trained to read the cable signals he had seen that day would be fit to take duty at any foreign station. Dr. Muirhead strongly advised the principal to urge his pupils to study cable-testing as well as the manipulation of the recorder, mirror, and Morse systems, and he laid particular stress upon their understanding the construction of the switches, keys, and all parts of the various instruments used on cables that often require adjustment. The artificial cable, the switches, and all the connections were made in the workshop of the College. The engineering pupils are now engaged in the construction of a second cable for the submarine department, which is to exceed in capacity the one that gave such satisfaction to Dr. Muirhead.—*Telegraphist.*

Electric Night Signalling.—The committee which is sitting at Keyham under the presidency of Admiral Sir William Dowell, K.C.B., for the purpose of inquiring into the important subject of day and night signals, have lately witnessed experiments at Devonport with three electric semaphores of different types, which have been placed on board the *Defiance*, torpedo ship, in St. German's river. In each case the arms of the semaphore could be distinctly seen and the signals read with accuracy and ease. The object of the trial was to ascertain which of the three semaphores is best adapted for use in the service; and a report on the matter will be presented in due course.

Electrical Appliances in the Army.—Captain I. R. J. Jocelyn, instructor in the Department of the Director of Artillery Studies, has received instructions to proceed to Devonport, in order to make himself thoroughly acquainted with the various details connected with electrical appliances made use of by inspectors of warlike stores.

Schanschieff's Battery.—Last week Mr. Christopher Davies favoured us with his views on this primary battery. In our correspondence pages this week Mr. Conry relates an experience which does not agree with that of our first-mentioned contributor. Mr. Schanschieff has, however, promised to bring one of his batteries before our notice, and we shall then publish our own results.

Watches Magnetised by Chest Protectors.—Last week we, in a moment of weakness which we now deeply regret, facetiously asked a question concerning the wearing of a chest protector on the back, a position which a correspondent informed us had been adopted by an acquaintance. That same correspondent, Mr. E. Hancock, M.E., send us the following with a request for its publication :—"The editors of this paper have publicly desired to know the effects of a magnetic chest protector when worn on the back of a person. Although I have my own ideas on the action of magnetism they are, of course, only imaginary. I do not pretend to explain the action of magnetism on the human system, only that it has become a therapeutic agent of the highest order. If its action could be explained correctly it would not make the slightest difference. It is sufficient at present to know that it does act beneficially on the system when applied sufficiently strong. A chest protecter is simply one half of a lung invigorator, which is intended to act on the lungs. If we take into consideration that half of a lung invigorator, which is usually called a chest protector, will affect anything a distance of six inches or more, and that the lungs are equally near to the back as the front, it will be seen that its action on the lungs will be the same if worn on the back or chest. Therefore, if a person has a watch it will be less affected by wearing the chest protector on the back without weakening its therapeutic action on the lungs."

The Queen and the Telephone.—Her Majesty was pleased to order the connection of her temporary residence, Newsham House, with the Town Hall, the Exhibition Buildings, the abodes of Earl Granville and the Mayor of Liverpool, and with the royal stables, &c., by means of the telephone during her short stay in Liverpool. The Queen expressed the utmost satisfaction, and said she had no idea that such wonderful strides towards perfection had been made. The whole of the special telephonic arrangements were carried out by Mr. Hope-Jones, under the able direction of the telephonic company's district manager, Mr. K. H. Claxton.

Our Columns.—We are compelled to leave over several letters and articles this week, owing to pressure of other important matter.

To our Subscribers.—We shall be glad if our subscribers, when writing upon any matters in which the ELECTRICAL REVIEW is concerned, would address their communications to the proprietors, H. Alabaster, Gatehouse & Co., and not to individual members of the firm.

Railway Contracts.—Messrs. Blakey, Emmott & Co., have again secured nearly the whole of the London and North Western Railway Company's contract for electrical apparatus and cotton-covered wire. They have also obtained a fair share of the Manchester Sheffield and Lincolnshire, and Lancashire and Yorkshire Railway contracts.

The Northern District Telephone Company.—This company is actively engaged in completing the circle of communication in the county of Durham, and before these lines are in print the trunk line between Stockton and Darlington will be opened, while a very large staff of men is employed upon the trunk between Sunderland and Wingate, which will be opened early in June, and forms the last link in the chain between Newcastle, Sunderland, and the towns in the south of the county. The new multiple switch board for the Sunderland Exchange has arrived, and is being fitted up. This will prove a very valuable acquisition, as the old switch boards were hardly equal to the work required of them, and would very soon have proved totally inadequate. The amount of work done in this district during the past half year is very large, the trunk lines alone reaching a total of over 250 miles, while Exchanges have been opened in East and West Hartlepool, Stockton, Middlesbrough, Darlington, and Durham, and the number of subscribers in these towns is very satisfactory.

Company Promotion.—An action was brought last week by Mr. Edward Brewis, stock and share dealer, against Mr. Godfrey S. Pearce, stockbroker, and Mr. Otto Rochs, electrician, all of London, to recover from them £2,000, which he alleged they obtained from him by false pretences. The action arose out of proceedings connected with the promotion by the defendants of an undertaking registered as the European, Canadian, and Asiatic Cable Company, which was to have a capital of a million and a-half sterling, in 75,000 £20 shares; and the plaintiff said he advanced his money on the assurance that a list of underwritings to the amount of £660,000 given to him was correct; that it was not correct, and that in the result, although certain allotments were made, the company was not floated. The defendants denied having made any false representations, saying that the plaintiff advanced his money simply as a speculation on being told that certain parties, including Henley's Telegraph Company, were prepared, in certain events, to enter into an agreement for underwriting certain amounts, and that the advance was made on the understanding and agreement that the plaintiff was only to be repaid out of any money coming to the defendants as promotion money. The trial ended in a verdict for the plaintiff for the £2,000, with costs.

NEW COMPANIES REGISTERED.

Self-Winding and Synchronising Clock Company, Limited.—Capital, £100,000 in £1 shares. Objects :—To purchase the letters patent, No. 15,500, dated November 25th, 1885, for "improvements in clocks, and apparatus for actuating or controlling the same by electricity," and No. 7,548, dated June 20th, 1885, for "improvements in synchronisers for clocks," the inventions of Mr. Chester Henry Pond, of Brooklyn, New York. Signatories (with one share each), J. H. A. Macdonald, 38, James Street, S.W.; J. F. Sandeman, 31, Chesham Street, S.W.; W. Clarke, C.E., 45, Parliament Street; D. Boyd, Lynn, Cheshire; W. Leatham Bright, 118, Leadenhall Street; J. A. Lund, 49, Cornhill; C. G. Nottage, 35, Collingham Road, S.W. The signatories are to appoint the first directors;

qualification, 200 shares; remuneration, £500 per annum, and also 10 per cent. of amount divided amongst the shareholders in excess of 10 per cent. per annum. Registered, 19th inst., by Messrs. Linklater & Co., 7, Walbrook, E.C.

Kinta Alluvial Tin Company, Limited.—Capital: £50,100 in £1 shares. Objects: To acquire a concession of lands from the Regent of Perak, situate in the Rasôk Valley, Kinta, and two town sites in Telôk Anson, a port on the Perak River, Straits Settlement, and to carry on mining operations. Also to erect a line or lines of telegraph, and to transmit and convey messages by the company's wire and to make charges, and to receive payment therefor. Signatories (with one share each): H. O. Jeyes, 25, Westbourne Terrace; *A. Rooke Farmer, C.E., Kinta; E. Brett, 7, Birchin Lane, E.C.; A. W. Rixon, 10, Austin Friars; J. W. Hutchinson, 89, London Wall; Isaac Carr, 10, Austin Friars; and G. Sanders, 7, Portugal Street, W.C. The first directors are Messrs. Metcalfe Larkin, A. R. Turner, C. E. and R. H. Pye. Qualification for future directors: 100 shares. Registered 20th inst. by Mr. Rixon, 10, Austin Friars.

Colchester Electric Light and Power Company, Limited.—Capital: £25,000 in £10 shares. Objects: To carry on in all branches the business of an electric light and power company. Signatories: *Thomas Moy, Stanway Hall; *J. Cooke Hopwood, Lexden Road; *E. Smith, St. Mary's Lodge; *E. J. Sanders, Cambridge Road; E. T. Smith, Beverley Road; *H. Grimwade, Head Street, 20 shares each; J. Paxman, Hythe Hill, 10 shares; all of Colchester. Directing qualification: Shares of the nominal value of £200. Remuneration: £1 1s. to each director for every board meeting attended, and such additional sum as the company in general meeting may determine. Registered 24th inst. by Mr. Conrad Fitch, 29, Bedford Row.

Sussex Electric Light Company, Limited.—Capital: £20,000 in £5 shares. Objects: To enter into contracts for electric lighting and for supplying electric light and energy for power or transmission. Signatories (with one share each): John Sayer, 25, Norfolk Road; S. Prince, 48, West Street; E. J. Allen Davis, 48, West Street; W. Prince, 12, Middle Street; W. E. Ayres, 27, Stanford Avenue; Col. W. H. White, 41, Albany Villa; all of Brighton; and C. E. Beard, of Lewes. Directing qualification: Shares or stock of the nominal value of £250; the signatories appointed first directors.

* Signatories whose names are preceded by an asterisk are also directors.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Railway and Electric Appliances Company, Limited.—The annual return of this company, made up to the 12th inst., was registered on the 22nd inst. The nominal capital is £500,000 in £1 shares. 130,201 shares have been taken up, and upon 51,701 of these 12s. 6d. per share has been called up, the remaining 78,500 being fully paid. The calls paid amount to £110,368 17s. 6d., and unpaid to £444 5s.

Welsbach Incandescence Light Company, Limited.—The first return of this company, made up to the 18th inst., was filed on the 24th inst. The nominal capital is £30,000 in £1 shares. 27,555 shares have been taken up, and the full amount has been called. The sum of £27,055 has been received in respect of calls, and £500 is considered as paid upon 500 shares.

Primary Battery Company, Limited.—The annual return of this company, made up to the 13th inst., was filed on the 20th inst. The nominal capital is £13,000 in £5 shares. The whole of the shares have been taken up and are fully paid, the paid up capital thus showing an increase of £6,700 as compared with the previous return.

CITY NOTES, REPORTS, MEETINGS, &c.

The West Coast of America Telegraph Company, Limited.

THE accounts for the year ending the 31st December, 1885, which the directors present to the shareholders show a gross revenue of £45,957 10s. 10d., against £52,011 10s. 7d., earned in the previous year. After deducting debenture interest and all other charges, there remains a net balance of profit of £12,890 12s. 2d., making together with £349 1s. 3d. brought forward from the previous year £13,239 13s. 5d., out of which the following dividends have been paid:—In June, 1885, 2s. per share, £3,000. In January, 1886, 3s. per share, £4,500, total £7,500, leaving an available balance of £5,739 13s. 5d.; of this amount the board recommend an addition of £5,000 to the reserve fund, which will then amount to £15,000, carrying forward £739 13s. 5d.

The unfortunate war between Chili and Peru, which happily is now at an end, has seriously affected the earnings of the company, and the general exhaustion caused by that protracted struggle will doubtless be felt for some time to come. However, there appear to be already some signs of improvement in the trade on the West Coast, and with the establishment of a more stable Government in Peru a gradual increase in the traffic may be expected.

The working expenses of the company show little variation from those in the previous year. Both cables and the repairing steamer are kept in perfect working order.

With great regret the directors announce the loss of the valuable services of their late Chairman, Mr. Robinson Kendal, who died very suddenly on March 13th last. The board has appointed in his place Mr. Alfred Marshall, formerly partner of the firm of Messrs. Frederick Huth, Grüning and Co., of Valparaiso and Lima, who has been for many years a resident on the West Coast.

The members of the board retiring by rotation are Mr. Henry Roberts and Mr. Alfred Marshall, both of whom, being eligible, offer themselves for re-election.

The West India and Panama Telegraph Company, Limited.

THE report of the directors presented at the 18th ordinary general meeting, held on Thursday (yesterday), states that the amount to credit of revenue is £38,008 18s. 7d., and the expenses have been £23,191 2s. 1d., leaving a balance of £14,817 16s. 6d., which, with the balance of £1,920 5s. 9d. brought from last account, makes a total of £16,738 2s. 3d. Of this sum the directors have placed £2,000 to reserve, leaving an available balance of £14,738 2s. 3d., with which it is proposed to deal as follows:—

	£	s.	d.
Payment of 6s. per share on account of arrears of dividend on the first preference shares ...	10,368	18	0
Balance to current half year's account	4,369	4	3
	£14,738	2	3

The traffic receipts for the half-year show a decrease of £2,176 8s. 11d. on those of the corresponding period of 1884. This decrease can only be attributed to the commercial depression which is affecting the West Indies, perhaps, even more severely than other parts of the world.

The company's ss. *Grappler*, referred to in the last report as being on her way home, has, after a thorough overhaul in the Thames, returned to the West Indies with 250 knots of cable on board, and the directors have great satisfaction in adding that she has since repaired the original Cuba-Jamaica section with an expenditure of 71 knots, thus duplicating a most important section of the company's system.

The duplicate Jamaica-Porto Rico cable, which it will be remembered was restored on the 24th October, 1884, again became interrupted on the 28th November last. The *Grappler* when on her way to repair the Cuba-Jamaica section was ordered to examine the locality of this interruption. The break was found to be in about 2,400 fathoms of water, and the repair will require the expenditure of a considerable length of new cable, as no workable depth was found along the course of this line in the vicinity of the interruption. The cable must, therefore, be recovered at the nearest practicable points on each side of the break, and a new length laid in between those points. As far as soundings hitherto obtained enable an opinion to be formed, some 160 knots of cable will be required to complete the connection.

The Trinidad-Demerara section has been again interrupted and as notwithstanding costly repairs it has not worked satisfactorily for some years, proposals have been made to the Colony of British Guiana for laying a new cable. The length that may be required for this renewal will be over 300 knots. If the company's proposals are accepted, the cost of this new cable, as well as that of the Cuba-Jamaica and Jamaica-Porto Rico repairs already referred to, will cause heavy drafts on the reserve fund.

Several breaks in the cables occurred during the half year under report, and have been repaired. All stations are now in telegraphic communication.

The shareholders were doubtless as much surprised as were the directors by the appearance in November last of an advertisement under the authority of the Postmaster-General announcing that

Her Majesty's Government were prepared to recommend Parliament to grant a subsidy for the construction and working of a submarine cable from Halifax (Nova Scotia) to Jamaica, *vid* Bermuda, and calling for tenders for the same.

The proposed line is part of a scheme that was before the Government in 1882, when, being adversely reported upon by the late Mr. Fawcett, the Postmaster-General at the time, it was rejected. Among the grounds of Mr. Fawcett's objections were the physical difficulties of the route between Bermuda and the West Indies, which passes over the greatest known depths in the world, and the evident injustice to the West India and Panama Telegraph Company which a State-subsidised competition would involve.

Mr. Fawcett's objections were apparently so fatal to the scheme, and so novel is the project of using the national resources to compete with a system the establishment of which had received the cordial encouragement of the Colonies and the approval of the Home Government, that the directors little expected to hear of it again, and they thought themselves justified in this belief by the facts that Jamaica is already connected with the nearest telegraph system by three of this company's cables, that it has been in telegraphic communication with England for the last 15 years, and that the volume of the whole West Indian telegraphic business is not sufficient to employ a single line of cable for more than about five hours a day. In these circumstances they could not imagine that Her Majesty's Treasury, which had invariably refused every application from this company for assistance in its efforts to continue the unremunerative telegraph service of the West Indian Colonies, would sanction the payment of a subsidy for an unnecessary fourth cable whose competition for the poor traffic of the region would seriously impair the power of this company to maintain the West Indian system.

The views of the directors on the proposal were communicated to the proper authorities. It is now six months since the appearance of the advertisement, and nothing has been since heard of the scheme. It is hoped, therefore, that it will be allowed to drop, and that this company will not have—to use Mr. Fawcett's words—"just cause for complaint against Her Majesty's Government if it were now to subsidise a rival company."

In accordance with the articles of association, Henry Holmes, Esq., and Henry Weaver, Esq., retire at this meeting and offer themselves for re-election.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending May 21st were £2,368, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

NEW PATENTS—1886.

6721. "Electric lamps." S. P. THOMPSON. Dated May 19.

6738. "Portable electric lamps, suitable for use in mines." J. W. SWAN. Dated May 19.

6805. "Electric arc lamps." R. H. COURTENAY. Dated May 20.

6806. "Materials suitable for use where electro-conductive material is required." T. MACE. (Communicated by Vitrite and Luminoid Company.) Dated May 20.

6839. "Electrical apparatus for indicating, &c., the speed of rotating bodies, such as shafts." W. T. GOOLDEN, A. P. TROTTER, P. CARDEW. Dated May 21.

6845. "Primary and secondary batteries." P. BAILLY. Dated November 6, 1885. (*Complete.*)

6863. "Electro-magnetic and other stringed musical instruments." R. K. BOYLE. Dated May 21.

6869. "Transforming heat into electricity and apparatus for that purpose." C. CLAMOND. Dated May 21.

6924. "Constructing and working electrical batteries." J. T. ARMSTRONG. Dated May 22.

6925. "System of electrical intercommunication between the carriages of railway trains." A. M. CLARK. (Communicated by M. M. Bair.) Dated May 22.

6957. "Galvanic batteries." M. KOTYRA. Dated May 24.

6968. "Conduits for electric cables or conductors." H. H. LAKE. (Communicated by J. F. Munsie and H. N. May.) Dated May 24. (*Complete.*)

6969. "Electric batteries." G. V. LAGARDE. Dated May 24.

7003. "Electro-magnetic transmitter." A. H. REED. (Communicated by J. T. Williams.) Dated May 25. (*Complete.*)

7004. "Generating electric currents." R. E. B. CROMPTON. Dated May 25.

7028. "Primary electric batteries." G. F. ROSE. Dated May 25.

7031. "Electric signalling apparatus, chiefly designed for use with telephones." H. H. LAKE. (Communicated by the International Dudley Signal Company.) Dated May 25. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1885.

4671. "Improvements in the manufacture of elements for voltaic batteries." D. G. FITZ GERALD. Dated April 15. 8d. Has for its object, first, the production of dense and coherent masses (moulded to any desired form) mainly composed of oxide of lead, and which masses are either to be reduced to porous metallic lead or converted into conductive peroxide of lead, for use as elements in voltaic batteries; secondly, to produce by chemical action a superficial coating of peroxide upon the whole or any portion of the masses to be converted into negative elements, whereby the masses can in some cases be used at once without further preparation by charging or whereby the operation of conversion into peroxide of lead by electrolysis is greatly facilitated. In carrying out this part of his invention, the inventor takes an oxide of lead, preferably the monoxide (litharge), for the production both of the positive and the negative elements of the battery. With this material he forms a plastic mass by mixing it with a solution that will effect a more or less gradual chemical change in the litharge and so cause it to "set" and to assume a dense and coherent condition. The solutions he prefers to use for this purpose are those of ammonic chloride, sulphate, carbonate, chromate, or phosphate; sodic or potassic chloride, sulphate or chromate or of an alkaline silicate or hypochlorite. With a view to further increase the hardness of the plates or elements, he prefers to add to the plastic mass a certain proportion of very finely divided lead in a moist condition. He then places a portion of the plastic mass in a mould of suitable form and applies pressure to consolidate the mass. In the manufacture of positive elements (*i.e.*, elements corresponding to the zinc in an ordinary voltaic couple) he simply maintains the plate or cylinder, produced as above described, in contact with a cathode surface in an electrolytic cell, or in contact with a plate of zinc (preferably amalgamated) immersed in a suitable electrolyte such as dilute sulphuric acid.

4720. "Improvements in wall brackets and suspensions for electric lamps." J. G. STAPELTON. Dated April 16. 8d. Consists in a removable wall bracket, which may either be rigid or swinging, and which is adapted to be supported upon and to travel along a rod or equivalent support affixed to the wall and combined with a barrel (which may be a self-coiling barrel or its equivalent) upon which is wound the necessary quantity of wire to admit of the desired removability of the bracket, the said barrel being mounted either on the bracket or on the wall in such way that the wire connection will be uncoiled when the bracket is moved away from and coiled up again when it is returned in towards the point where the wire enters or is fixed to the wall of the room.

5006. "Improvements relating to electric meters." S. F. WALKER. Dated April 22. 8d. Consists essentially of a rotating armature included in the circuit of the lamps and an electro-magnet or electro-magnets included in a shunt taken across the said circuit. The armature is geared in connection with any suitable index or counter or indicating apparatus. The resistance of the said shunt is constant, so that while the difference of potential at the points of junction with the mains is constant the current in the shunt will be constant and the intensity of the magnetic-field will be constant except as it may be affected by the counter electromotive force generated in the armature and the reactions between the said armature and magnets.

5123. "Improvements in the method of exciting the field-magnets of series-wound dynamo machines." W. H. ALLEN, R. WRIGHT, and G. KAPP. Dated April 24. 8d. Consists in joining the terminals of the series coils (in addition to the usual connection with armature and outer circit) with an auxiliary source of electricity. The source of the auxiliary current may be a primary or secondary battery, or a separate small series wound dynamo, the terminals of which are connected to the terminals of the series coils of the main dynamo.

5147. "Improvements in electric arc lamps." J. G. STATTER. Dated April 25. 8d. Relates to an improved method of disposing the magnetisable parts under the influence of the helices used to supply the motive power to electric arc lamps, and to the construction of band or flexible brakes, applied to a disc such as is referred to in a former provisional specification No. 17,008 of December 29th, 1884. In carrying out the present improvements a sheathing of iron is placed round the solenoid and provides a more complete magnetic circuit—namely, through the core to the magnetisable disc, which may, or may not be toothed, and completing its circuit by the sheathing, the air space traversed by the magnetic lines of force being thereby very much diminished. For preventing the disc from turning the inventor employs a device consisting of a flexible brake such as a cord or a thin band of metal hereinafter called "the band," which passes round the periphery of the disc. One end of this band is connected with the core of the solenoid; the band then passes round part of the periphery of the disc and is kept upon it by suitable means such as by a weight or a spring or by a weighted lever. The band adheres to the periphery of the disc by friction except for certain positions of the disc, when the pull of the weight or spring is relieved by contact with a stop, or when the tension of the spring is less by reason of eccentric attachment—or when the moment of the weighted lever is less by reason of its position—the friction of the band upon the disc is then so lessened that the tendency of the rack to turn the disc overcomes it and a feed takes place.

7584. "Improvements in telegraphy." T. J. HANDFORD. (Communicated from abroad by T. A. Edison, of Menlo Park.) Dated June 22. 8d. The object of the invention is to increase the capacity of local telegraph lines or those lines having one or more way stations in addition to the terminal stations by the production of apparatus by means of which two sets of independent and non-interfering Morse signals can be sent back and forth over the line between terminal stations or terminal and way stations or way stations alone. In carrying out the invention there are employed for receiving instruments at each terminal and way station an ordinary non-polarised relay which acts by changes in the strength of current without regard to its polarity and a polarised relay acting by changes in the polarity of current without regard to its strength. The line is provided with a constant current from a main battery of a suitable number of cells which is decreased by the manipulation of a Morse key at each station such keys normally short circuiting a large resistance and throwing such resistance into line when depressed. The non-polarised relays which respond to this variation in current close sounder circuits at their back points. In order to reverse the polarity of the constant line current without changing its strength, there is provided at each terminal and way station, a battery, controlled by the manipulation of a key, which battery has twice the number of cells of the main battery, and which is thrown into circuit reverse to and opposing the main battery. This local battery is normally out of circuit and when thrown in neutralises the current of main battery and produces a current of opposite polarity equal to the normal current of the main battery. By these means it will be seen the line current can be reversed at any station, whether way or terminal, thus operating the polarised relay and without affecting the non-polarised relays.

7881. "Improvements in electric clocks." A. M. CLARK. (Communicated from abroad by A. Sauer, of Germany.) Dated June 29. 8d. Relates to improvements in primary and secondary clocks, the one acting to open and close circuit and thereby control the other. In place of the pressure or press contact, the inventor employs a sliding or passing contact to put and keep in motion a self acting pendulum or regulator worked by electricity. This sliding or passing contact is constructed in such a manner that the passing or sliding parts only work upon each other intermittently for a very short period, which results in the contact parts keeping clean and neither burning nor oxidising, so that the pendulum is never interrupted or hindered in its beats. The pallet escapement is also greatly simplified and is constructed without pivots or counter weights, which obviates the use of oil; thus a sticking of the escapement through gumming on of oil is obviated.

8416. "Method of constructing electrode frames for secondary voltaic batteries." A. KHOTINSKY. Dated July 11. 6d. Relates to a method of constructing frames suitable for holding the pulverulent or pasty material, such as oxides of lead, employed in secondary electric batteries.

8811. "Improvements in synchronous movements and telegraphy." P. B. DELANY. Dated July 21. 10d. Relates to improvements in the apparatus described in patent specification No. 4,787, of October 6th, 1883.

9302. "Improvements in galvanic batteries." A. R. UPWARD and W. C. PRIDHAM. Dated August 4. 8d. Relates more especially to batteries which are maintained in an active condition by the passage of gaseous chlorine through the cells. The inventors cause the gas to be delivered from the generator into the lower part of a high column or vertical pipe or pipes open at the top and also connected near the bottom by a suitable tube with the battery or batteries to be supplied. At the outlet from each battery they provide an aspirator or other form of pump in which a jet of water operates to propel the air, and they also provide an electric governor which controls the water current of the aspirator in accordance with the electric current delivered by the battery.

9564. "Improvements in electrical synchronous movements." A. L. PARCELLE. Dated August 11. 11d. Relates to apparatus for purposes similar to those of the Delany multiplex telegraph apparatus.

10540. "Improvements in electric measuring instruments." J. G. STATTER. Dated September 5. 8d. The inventor takes a coil and places within it a laminated soft iron needle of very small mass in such a position that it is not only acted upon by the deflective action of the coil, but experiences a force tending to draw it to the centre of the coil with respect to its length, after the well-known manner in which a solenoid acts upon its core; and the needle is placed in such a position with respect to its axis of rotation, that this force acts in conjunction with the hereinabove described turning force and supplements it, its movement increasing when that of the turning force is diminishing, and it is by the combination of this force with the turning force that the inventor obtains a much more even scale and a greater available range.

13011. "Improvements in electric arc lamps." W. E. HEYS. (Communicated from abroad by O. P. Loomis and H. W. Cooley, both of America.) Dated October 29. 8d. Relates more particularly to the clutch for regulating the distance between the carbons, and to an automatic cut out for throwing the lamp out of the main circuit under abnormal conditions. It also relates to the combination of certain elements which go to comprise a lamp as an entirety.

CORRESPONDENCE.

The Franklin Institute Lamp Tests.

In reply to the second letter of Messrs. Woodhouse and Rawson regarding the Duration Tests of Incandescent Lamps made by a committee of this institution, I hand you copy of a letter written by myself, which I trust that you will publish. This letter was sent and no reply received. As it has not returned through the Dead Letter Office, the inference that it was received is natural. I regret to prolong this discussion, but would like to have it known that an earnest effort was made to advise Messrs. Woodhouse & Rawson of the fact that their lamps were being tested.

Wm. D. Marks.

Philadelphia, *May 12th*, 1886.

[COPY.]

"Messrs. Woodhouse & Rawson,
"Electrical Engineers, London, England.

"Gentlemen,—Will you kindly send us such particulars regarding the manufacture of your carbons for incandescent lamps as you desire to have made public. I desire them for the forthcoming report of the Franklin Institute's Duration Tests.

"Very truly yours,
"**Wm. D. Marks.**
"*Chairman Executive Committee.*

"Philadelphia, *March 26th*, 1885."

Long Distance Telephony.

It was anticipated that when so high an authority as Mr. W. H. Preece proposed reading a paper before the Society of Telegraph Engineers on the above subject, that some practical means of accomplishing the desired purpose would be submitted. But instead of that we are treated to a *résume* of comparative statements as to the number of telephones in use in the various countries or nationalities, which, however interesting to the purchasers of Bell's original patents, is not of value from a scientific point of view.

To my mind Prof. Thompson was very much nearer the mark in saying that the way to accomplish long distance speaking was in the use of more powerful currents and less sensitive receivers, *i.e.*, such receivers as would ignore or not be affected by inductive currents that kill speech in the Bell instrument. The circuit referred to by Mr. Preece as running from the G. P. O. to the Gloucester Road Stores is certainly the worst I know of for destroying speech—in fact, I believe it is nicknamed "Kill-telephone," and it is the delight of postal officials to place it at the disposal of any sanguine inventor of a new telephone he desires to submit. In 1884 I made a receiver with the special object of ignoring those powerful disturbers, heavy inductive currents from Wheatstone wires, and got it tried upon this very wire. There was perfect silence when in circuit, and the Morse signals were read quite clear when the circuit was worked. Now had there been a transmitter equal to the Morse, I am convinced speech would have been possible, and the best form for such would have been the Hunnings. I believe were long distance working proved practicable, there would soon be a demand created for it. The late "Long Distance Telephone Company, Limited," had some £95,000 subscribed in one day; but they lacked the necessary instruments to work with.

Magneto.

[Our correspondent seems to have misunderstood the reasons why long distance telephony under certain

conditions was found to be impossible. With underground wires or aerial wires of iron, after a certain distance the sounds become indistinguishable not because they are overpowered by external disturbances, but because they become muffled; an increase in power of the transmitter would make these muffled sounds louder but not more distinct. The use of an aerial copper wire, on the contrary, renders the articulation perfectly clear.—EDS. ELEC. REV.]

Galvanometer Problem.

Will you permit me to call attention to an error in the solution of the galvanometer problem, page 480?

The tan. 30° is $\frac{1}{\sqrt{3}}$, not $\sqrt{3}$ as there stated; so that

$$R_1 : R_2 :: 3 : 1.$$

If the two galvanometers were wound with wire of the same gauge, but one containing three times as many layers as the other, the deflection of the former must be greater than that of the latter, whereas the solution given would make it less.

PI.

May 24th, 1886.

[We are obliged to our correspondent for drawing attention to the numerical error, which was made inadvertently; the mistake does not of course affect the general solution of the problem.—EDS. ELEC. REV.]

Professor Thompson's New Telephone Receiver.

In your issue of April 30th of this year on page 405, you illustrate a telephone receiver by Professor Silvanus Thompson, which, so far as I can judge, is a form patented by Mr. José D. Husbands in 1881 or 1882, and which was referred to by you in an article upon that gentleman's telephones in 1883, in which it was pointed out that the "wriggle" produced in the upper diaphragm, by the action of the current on his armatures working within the solenoidal coil or coils (as illustrated in Pat. 4,423, 1885, *i.e.*, Professor Thompson's) gave out speech just as good and clear as in the ordinary form of telephone. It is in fact but Husband's "Electro Mechanical Telephone" with the slightest possible modification, which anyone knowing the former instrument would at once detect. As the United people considered that an infringement, I do not see that this later imitation can be clear.

"Wriggle."

Schanschieff's Battery.

Referring to the letter of Mr. G. C. Davis anent Schanschieff's battery, it may add a mite of information to the subject if I say that I have tried this battery, and find it to be not superior in E.M.F. to the old bichromate and several others, while like most single fluid batteries that I have met, it appears to have an unpleasant habit of coating the zinc plate with a bad deposit, especially if the zinc be hoisted out of the liquid and left to dry as in the bottle bichromate. It reminded me very much of the green chromate that gives such trouble with single fluid bichromates by forming on the zinc.

Added to this, the squeezing of the deposit through washleather is a troublesome and messy business, very detrimental to the skin of the hands and to the clothing.

So far from being an improvement, I do not think it is as good as one or two single fluid batteries that we have already, the liquid of which can be thrown away when exhausted; and the prime cost is heavy. I have not reckoned up the ultimate cost, because I did not think it worth while to go into a series of experiments on the subject, as the salt formation that comes on the zinc over the amalgamation would, to my thinking, nullify the superiority of the battery if nothing else did.

Edward Coury.

23, Villiers Street, New Bushey,
May 22nd, 1886.

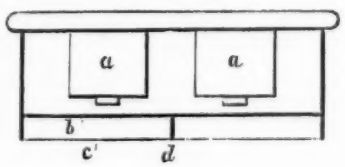
Improvements in Telephones.

In an article in your valuable paper on "Ebel's Improvements in Telephonic Apparatus," you state "that the employment of several electro-magnets to one diaphragm is a complete delusion."

Now, sir, I should like to show you that in saying so, you make a mistake.

A friend of mine, Mr. Blenheim, of New Egham, Surrey, has invented an electrical telephone, in which the employment of two electro-magnets doubles the effect.

Now, in all ordinary telephones such as Bell's, in which an iron diaphragm is used, you are quite right in saying two electro or other magnets do not double the effect. But supposing you place them thus: *a*, *a*, are two electro-magnets, *b* is a soft iron armature, *c* is a membrane of paper, and *d* is a sound post to connect the two.



Now, it is quite evident that whatever impulses are given to *b* must be communicated to the centre of the membrane, *c*. Thus no confusion of sound waves arises in the membrane.

This instrument both transmits and receives speech better and louder than any other telephone I have heard. There being no carbon in it, one can either shout or speak low into the transmitter with very little difference in the receiver.

If you think this would interest any of the readers of the ELECTRICAL REVIEW you might publish it.

W. F. S. Ashby.

Corner Hall, Staines,
May 24th, 1886.

[We should be glad to take advantage of an opportunity for trying these instruments.—EDS. ELEC. REV.]

Incandescent Lamp Making.

I hope to avail myself of Messrs. Heap and Stuart's kind offer; if their voltmeter really possesses the qualities they claim for it, I should think no other at present in the market would be able to compete with it.

I have examined the instruments mentioned by "Ajax," but they are all unsuitable for constant practical work, and especially when used continuously as I should require. I am sorry I am unable to oblige "Ajax" by describing the process of recalibration of the Cardew's and Ayrton and Perry's voltmeters, as I always return them to the respective makers, after having first tested them by a Siemens' universal galvanometer.

With reference to incandescent lamp making, I really hope some reliable information as to the scientific processes the fibres undergo will be forthcoming, through these columns, as after the recent trial a fine field for discussion is opened. To my mind, the chief process, viz., the flashing of the carbons to bring them to a certain resistance, is kept quite secret.

Very Anxious.

May 25th, 1886.